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Rate Training
Manual

UNITED STATES NAVY

Damage Controlman 3 & 2

DISTRIBUTION STATEMENT A

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Although the words "he," "him," and "his" are used sparingly in this manual to enhance communication, they are not intended to be gender driven nor to affront or discriminate against anyone reading *Damage Controlman 3 & 2*, NAVEDTRA 10572.

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Naval Education And Training Program Development Center

DAMAGE CONTROLMAN
3 & 2

NAVEDTRA 10572

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL EDUC AND TNG

1986 Edition Prepared by
HTC Patrick F. Wilberding and
HTC(SW) Alfred J. Grace, Jr.

PREFACE

Damage Controlman 3 & 2, NAVEDTRA 10572, is a rate training manual (RTM) which, when combined with its nonresident career course (NRCC), NAVEDTRA 80572, form a self-study package that provides training to all personnel preparing for advancement to DC3 and DC2.

The primary purpose of training is to produce a combat-ready Navy that can guarantee victory at sea. That victory depends upon the readiness of the personnel.

Each individual is assigned tasks depending upon the needs of the ship. The information in this manual relates to the damage control tasks that are assigned to personnel serving aboard ships as a DC3 or DC2. These tasks are required to maintain and protect the ship and its systems. When we have personnel aboard who can and do perform these tasks efficiently, we will have each ship operating at the high state of readiness that is essential to victory at sea.

When you are assigned duties aboard ship as a DC3 or DC2, you will be expected to know and understand the information in this manual. The success of the Navy depends in part on your ability and the manner in which you perform your assigned duties.

Damage Controlman 3 & 2, NAVEDTRA 10572, was prepared by the Naval Education and Training Program Development Center, Pensacola, Florida, for the Chief of Naval Education and Training. Technical assistance was provided by the Naval Sea Systems Conmand; the Naval Damage Control Training Center, Philadelphia; Naval Schools Command, Treasure Island, San Francisco, California; the Service School Command, San Diego, California; and the Naval Technical Training Center, Millington, Tennessee.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CHAPTER 1

THE DAMAGE CONTROLMAN RATING

The Damage Controlman rating is a general rating. There are no service ratings.

As you study the requirements for advancement to DC3 and DC2, you will notice that the rating covers a wide variety of subject matter. As a Damage Controlman, you will perform organizational and intermediate level maintenance and repair of damage control equipment and systems; plan, supervise and perform tasks necessary for damage control, ship stability, preservation of watertight integrity, firefighting, and chemical biological and radiological (CBR) warfare defense; instruct and coordinate damage control parties; instruct personnel in the techniques of damage control and CBR defense; supervise and perform tasks in procurement and issuance of supplies and repair parts; and prepare records and reports.

As you advance to DC3 and then to DC2, you will find that you have increasing responsibilities for military and technical leadership. Your responsibilities for military leadership are about the same as those of petty officers at the same level in other ratings; every petty officer must be a military leader as well as a technical specialist. Your responsibilites for technical leadership are special to your own rating and are directly related to the nature of your work.

Your ability to lead other men is particularly important. In casualty situations, damage control can become an all hands evolution, with damage controlmen holding key positions in the damage control organization. In order to coordinate the efforts of many men for the successful control of damage, you must possess qualities of leadership as well as skills and knowledge in the field of damage control. Organization and teamwork are the keys to successful damage control. Strong leadership is required to keep the organization functioning and to ensure effective teamwork needed to meet the following goals:

1. Preserve or reestablish watertight integrity, stability, maneuverability, and offensive power
2. Control list and trim
3. Repair material and equipment
4. Limit the spread of, and provide protection from, fire
5. Limit the spread of, remove the contamination by, and provide adequate protection against, chemical and biological agents or noxious gases and nuclear radiation
6. Care for wounded personnel

Shipboard damage control will work toward these three basic objectives:

1. Take all practicable preliminary measures to prevent damage
2. Minimize and localize damage as it occurs
3. Accomplish emergency repairs as quickly as possible, restore equipment to operation, and care for injured personnel

The damage control organization has the same objectives whether the country is at peace or at war. The ship's ability to perform its mission will depend upon the effectiveness of its damage control organization.

To attain these objectives, we need to accomplish the following actions:

1. Preserve stability and fume-tight and watertight integrity (buoyancy).
2. Maintain the operational capabilities of vital systems.
3. Prevent, isolate, combat, extinguish, and remove the effects of fire and explosion.
4. Detect, confine, and remove the effects of chemical, biological, or radiological contamination.

5. Prevent personnel casualties and administer first aid to the injured.

6. Make rapid repairs to correct structural and equipment damage.

Damage control includes the following areas of responsibility:

1. The functional combination of all equipment, material, devices, and techniques that prevent and minimize damage and restore damaged equipment and structures. This damage can occur in wartime or peacetime.

2. The passive defense against conventional, nuclear, biological, and chemical warfare.

3. All active defense measures short of those designed to prevent successful delivery of an enemy attack by military means or sabotage.

In the rest of this chapter, we will discuss the damage control responsibilities of various individuals, DC training, DC personnel qualification standards, and sources of information.

DAMAGE CONTROL RESPONSIBILITIES

Damage control is the responsibility of all hands. All personnel must know their assignments within the damage control organization and understand the importance of those assignments. Damage control cannot be overemphasized. The necessary state of readiness can only be achieved through a reliable program. The program must be supervised by an influential and energetic individual who is enthusiastic, well-trained, and determined. While we might not cover all areas completely, we will cover the basic responsibilities of key individuals.

The *Surface Ship Damage Control* manual, NWP 62-1, describes the duties and functions of various ship's personnel. The following responsibilities are taken from *U.S. Navy Regulations, 1973*; NWP 62-1; and OPNAVINST 3120.32A. They apply only to damage control. These responsibilities do not supersede or cancel those covered in *U.S. Navy Requlations, 1973*; NWP 62-1; or OPNAVINST 3120.32A. Damage control is the responsibility of all hands. That includes everyone in each department aboard ship from the newest recruit to the commanding officer.

COMMANDING OFFICER

Chapter 7 of *U.S. Navy Regulations, 1973* describes the various broad responsibilities of the commanding officer (CO). One of the requirements is that the CO " . . . maintain his command in a state of maximum effectiveness for war or other service . . . ." The CO should "Immediately after a battle or action, repair damage so far as possible, (and) exert every effort to prepare his command for further service . . . ."

To carry out this charge, the commanding officer must ensure that the command is adequately trained. This training is done through lectures, schools, and continual exercises in all aspects of damage control. The commanding officer should be fully aware of all of the ship's weaknesses. These include the inadequacy and inoperability of all damage control equipment. Shortages and defects should be corrected immediately.

EXECUTIVE OFFICER

The executive officer (XO) advises the commanding officer on the status of the ship's damage control readiness. The XO ensures that responsible personnel carry out the following requirements.

1. Conduct damage control training for the ship's company.
2. Maintain ship's readiness to combat all casualties and damage that threaten the ship.

The XO must be intimately familiar with all damage control evolutions. This includes supervision of all actions related to damage control.

OFFICER OF THE DECK

The officer of the deck (OOD) is the senior member of the underway watch team. As the primary assistant to the commanding officer on the bridge, the OOD will carry out the following duties and responsibilities:

1. Be intimately familiar with the ship. This includes its material condition and the established procedures for emergencies.
2. Know the correct course of action or options for various damage control situations.
3. Promptly analyze a situation and take prompt, positive, and correct counteraction.
4. In the absence of the commanding officer, maneuver the ship.

The OOD's ability to act properly and promptly will be in direct proportion to that officer's training, knowledge of the ship, damage control procedures, and equipment available.

COMMAND DUTY OFFICER IN PORT

The command duty officer (CDO) in port is designated by the commanding officer. This officer is eligible for command at sea and is the deputy to the executive officer for a prescribed period of time. The CDO will carry out the following duties and responsibilities.

1. Carry out the ship's daily routine in port.
2. Carry out the duties of the XO during the temporary absence of that officer.
3. Advise and, if necessary, direct the OOD in matters concerning the general duties and safety of the ship.
4. Keep informed of the ship's position, mooring lines, or ground tackle in use.
5. Know the status of the engineering plant, and all other matters that affect the safety and security of the ship.
6. In times of danger or emergency, take any action necessary until relieved by a senior officer in the succession of command.
7. Relieve the OOD when necessary for the safety of the ship, and inform the commanding officer when such action is taken.

DEPARTMENT HEADS

We can achieve adequate damage control readiness only by the participation of all departments aboard ship. For this reason, each department head will carry out the following duties and responsibilities.

1. Ensure that the material conditions of readiness within the department are at their best. These conditions are prescribed by compartment checkoff lists provided by the damage control assistant (DCA). The DCA is discussed later in this chapter.
2. Provide for continual and periodic inspections of department spaces in accordance with current planned maintenance system (PMS) procedures.
3. Require that damage control equipment and fittings be maintained in their proper locations and in operating order.
4. Assign specific damage control duties to individuals within the department. Included will be the designation of a departmental damage control chief petty officer (DDCPO) for the department and a division damage control petty officer (DCPO) for each division within the department.
5. Provide personnel for damage control, repair, fire, salvage, and rescue parties, and for other assignments as required by the ship's organization bills.
6. Require that departmental material and equipment are secured to protect them from damage by heavy seas.
7. Require an immediate report to the DCA of any deficiency in damage control markings, devices, fittings, equipment, or material, and initiate corrective action.
8. Train personnel in damage control matters, in coordination with the DCA.
9. Be prepared to strip ship, or clear for action, in accordance with the ship's instructions.

ENGINEER OFFICER

The engineer officer is also known as the damage control officer. This officer is responsible to the commanding officer for the following duties and responsibilities:

1. The operation, care, and maintenance of the main propulsion plant, auxiliary machinery, and piping systems
2. The control of damage
3. The operation and maintenance of electric power generators and distribution systems
4. The repairs to the hull
5. The repairs to material and equipment of other departments that are beyond the capacity of those departments but within the capacity of the engineering department

In amplification of duties in *U.S. Navy Regulations, 1973* the engineer officer is required to carry out the following duties and responsibilities.

1. Maintain the hull, machinery, and electrical system in battle readiness.
2. Supervise fire fighting. Ensure that the ship's fire bill is adequate. Assign and instruct personnel in accordance with the provisions of the bill.
3. Maintain interior communication equipment.

4. Control and restore engineering and ship control casualties.

5. Coordinate all naval shipyard work. This includes all correspondence or communications on alterations or repairs to the hull and installed equipment.

6. Maintain the PMS and other operating and maintenance records.

7. Act as technical assistant to the executive officer to carry out chemical, biological, and radiological (CBR) defense procedures.

8. Provide ship facilities, equipment, and key personnel to repair the hull and machinery. Ensure repairs to material and equipment of other departments that are within the capacity of the engineering department.

9. Organize Repair 5 (Propulsion) in accordance with the ship's battle bill.

10. Supervise the training of Repair 5.

11. Assign appropriate engineering ratings to other repair parties in accordance with the ship's battle bill.

DAMAGE CONTROL ASSISTANT

The damage control assistant (DCA) is responsible, under the engineer officer, for the control of damage. This includes the control of stability, list, and trim. It also includes fighting fires, repairing damage, and maintaining CBR defense.

The DCA is the overall coordinator of damage control matters within the command organization. This responsibility includes the ship's damage control training program. During emergency situations, the DCA controls the damage control problem with the technical advice and assistance of all departments. Fires and other damage that occur while the ship is at general quarters will be handled as a battle casualty. Corrective action under the direction of the DCA will be taken by the repair parties in the vicinity. On aircraft carriers, the ship's air officer will direct repair parties for fires in aircraft or associated equipment on the flight deck or in the hangar bays.

The DCA will carry out the following damage control duties and responsibilities:

1. Prepare directives for the signature of the commanding officer in connection with all damage control functions requiring coordination of departments.

2. Submit to the planning board for training, a schedule of all-hands damage control training requirements, including battle problem requirements.

3. Prepare a damage control training syllabus and provide damage control instructors for all-hands training.

4. Furnish standard damage control equipment (tools, portable lights, and portable pumps) to repair party lockers and to other prescribed locations throughout the ship. Conduct periodic inspections of such equipment.

5. Assign Damage Controlmen and Hull Maintenance Technicians to various repair parties in accordance with the ship's battle bill and manning document.

6. Conduct inspections throughout the ship, accompanied by the cognizant department head, to ensure that the ship's watertight integrity is maintained. Ensure that all departments are maintaining a high degree of damage control readiness.

7. Ensure that the master damage control book is updated whenever alterations are made to the ship.

8. Ensure that damage control compartment checkoff lists are posted.

9. Ensure that damage control markings, routes, stations, and labels are posted throughout the ship.

10. Ensure that emergency escape routes to weather decks are clearly labeled.

11. Maintain a damage control central (DCC) with facilities to evaluate damage to the ship's hull and equipment and to make decisions to counteract the effects of such damages. Coordinate repair parties and keep the commanding officer informed of major developments.

12. Prescribe routes for transporting injured personnel to battle dressing stations.

13. Ensure that an effective organization is always present for execution of each of the emergency bills.

14. Inform the engineer officer of any condition or practice that lowers the damage control readiness of the ship.

15. Organize Repairs 1, 2, 3, 4, and 7 in accordance with the ship's battle bill.

16. Personally direct the training of Repairs 1, 2, 3, 4, and 7, and DCC personnel.

17. Ensure, in coordination with department heads, that DDCPOs and DCPOs are trained to accomplish their assigned duties.

18. Act as, or supervise the duties of, the gas free engineer.

19. Ensure that a liquid load status is provided daily to damage control central and all repair lockers (list status in feet and inches).

DAMAGE CONTROL WATCH OFFICER

The damage control watch officer (DCWO), when assigned, will carry out the following duties and responsibilities:

1. Supervise the maintenance of any material condition of readiness in effect on the ship. This includes the responsibility to check, repair, and keep the various hull systems in full operating condition.
2. Report directly to the OOD on all matters affecting the watertight integrity, stability, or other conditions that affect the safety of the ship.
3. Report to the DCA for technical control and matters affecting the administration of the watch. The damage control patrols and the petty officers in charge of repair parties report to the DCWO.
4. Maintain a written damage control log. The log entries will show the hourly readings of the firemain pressure and the number of fire pumps in operation. Make entries such as the ship's getting underway, anchoring, and mooring. Include special evolutions such as general quarters, emergency drills, and the setting of material conditions, the discrepancies reported, and the corrective action taken.
5. Supervise the maintenance of the ship's damage control closure log. List all fittings that are in violation of the prescribed material condition of readiness. Entries will show the following information:

    a. Name of the person requesting permission
    b. Rate of the person requesting permission
    c. Type of fitting opened
    d. Identification of the fitting
    e. Classification of the fitting
    f. Time the fitting was opened
    g. Estimated time the fitting is to remain open
    h. Time the fitting was closed
    i. Name of the person granting permission
    j. Rate of the person granting permission

Make all entries in ink; no erasures are to be made. Correct all errors by drawing a line through the error and initialing it. Make the correct entry on the following line. The dates for opening the fitting include the day, month, and year. Keep the closure log sheets on file for a period of 6 months.

The estimated time open will not be more than 24 hours. At the end of the 24 hours, the fitting will either be relogged open or logged closed. Anyone who violates the material condition of readiness in effect without permission to do so will be subject to disciplinary action.

6. At the end of each watch, obtain from the ship's oil king a report on which fuel tanks were emptied during the watch. List in the damage control log the compartment numbers of the tanks and whether or not they have been ballasted.
7. Report hourly to the OOD on the status of the ship's watertight integrity.
8. When the ship is under way, have the sounding and security watch take and report soundings of all voids and cofferdams at least once during each 4-hour watch. While in port, take soundings at least once each day. In addition, have the watch check the material condition of readiness in their respective areas. Report any corrective action taken in this respect.
9. Ensure that the draft is taken, or computed if at sea, and logged daily on the 0400 to 0800 watch. The draft should be taken daily, before entering or leaving port, before and after fueling, when taking on supplies, or when rearming.
10. Notify the OOD, DCA, and weapons department duty officer when the fire alarm board indicates that the temperature of any magazine is above 105°F.
11. Ensure that the master key to the repair lockers is issued only to authorized personnel.
12. Daily at 1700, request the OOD to have the word passed, "All divisions check the setting of material condition YOKE. Make reports to damage control central." After a half hour, ensure that any division that has not reported does so.

FIRE MARSHAL

Large ships, such as aircraft carriers, may have a fire marshal assigned. The fire marshal is an assistant to the engineer officer. The duty of the fire marshal is to help the DCA prevent and fight fires. The fire marshal must be thoroughly familiar with the following documents:

1. *Gas Free Engineering, Naval Ships' Technical Manual*, chapter 074, volume 3
2. *Practical Damage Control, Naval Ships' Technical Manual*, chapter 079, volume 2
3. *Fire-fighting Ship, Naval Ships' Technical Manual*, chapter 9930
4. Ship's instructions

5. Ship's plans
6. Ship's compartmentation

The fire marshall should conduct daily inspections throughout the ship, paying particular attention to good housekeeping, fire equipment, and fire and safety hazards.

The fire marshal reports fire hazards and recommends corrective action. These reports are submitted to the DCA with copies to the XO and appropriate department heads. A follow-up inspection should be made to ensure that corrective action has been taken.

The fire marshall should also carry out the following duties and responsibilities:

1. Train the ship's fire teams, rescue and assistance teams, and DDCPOs.
2. Prior to overhauls or major repair availabilities, set up and train a ship's fire-watch team and make their assignments.
3. Take charge at the scene until relieved at general quarters. Keep DCC or the OOD informed of the exact status of the situation.

DIVISION OFFICER

The division officer takes all practicable preventive measures before damage occurs. This includes maintenance of the ship's watertight and airtight integrity, removal of fire hazards, and maintenance of emergency equipment. This is done by making daily inspections of divisional spaces and equipment to verify that they are maintained in the best possible condition. The following publications are helpful to the officer conducting these checks.

1. *Practical Damage Control, Naval Ships' Technical Manual*, chapter 079, volume 2
2. *Inspections, Tests, Records, and Reports, Naval Ships' Technical Manual*, chapter 090
3. *Lighting, Naval Ships' Technical Manual*, chapter 330
4. *Fire-fighting Ship, Naval Ships' Technical Manual*, chapter 9930
5. *General Specifications for Ships of the U.S. Navy*, chapter 602

Most of these checks and inspections are done by the DDCPO, who is discussed next. Any discrepancies that the DDCPOs cannot correct should be reported to the division officer. Any discrepancies the division officer cannot correct should be referred to the DCA. The DDCPO conducts most of the checks, but the division officers are still responsible for visual inspections of their spaces.

DEPARTMENTAL DAMAGE CONTROL CHIEF PETTY OFFICER

On large ships, a departmental damage control chief petty officer (DDCPO) will be assigned. The DDCPO assists the DCA by carrying out the following duties and responsibilities:

1. Coordinate the relieving, qualifying, and training of the divisional damage control petty officers (DCPOs) within the department.
2. Inform the DCA and fire marshal of any changes of personnel assigned as DCPO.
3. Ensure that the DCPOs are performing their duties.
4. Perform other duties as directed by the DCA, the fire marshal, and the type commander.

DIVISION DAMAGE CONTROL PETTY OFFICER

A senior petty officer within each division is assigned as the division damage control petty officer (DCPO) for that division. The DCPO is responsible, under the division leading petty officer (LPO), for damage control functions of the division and related matters. Outside normal working hours, duty division section leaders will perform DCPO duties on their duty days.

Each DCPO should carry out the following duties and responsibilities:

1. Understand all phases of the ship's damage control, fire fighting, and CBR defense procedures.
2. Assist in the instruction of division personnel in damage control, fire fighting, and CBR defense procedures.
3. Ensure the preparation and maintenance of damage control compartment checkoff lists for all divisional spaces.
4. Supervise the setting of specified damage control material conditions within divisional spaces and make required reports.
5. Weigh portable CO_2 bottles, inspect and test damage control and fire fighting equipment, and prepare required reports for approval by the division officer in accordance with current ship's instruction.

6. Ensure that the required battle lanterns, dogging wrenches, spanner wrenches, and other damage control equipment are in place and in a usable condition in all divisional spaces.

7. Ensure that all compartments, piping, cables, and damage control and fire fighting equipment are properly stenciled or identified by color codes.

8. Ensure the posting of safety precautions and operating instructions in required divisional spaces.

9. Assist the division officer in the inspection of divisional spaces for cleanliness and preservation, and assist in the preparation of required reports.

10. Conduct daily inspections of divisional spaces for the elimination of fire hazards.

11. Perform such other duties with reference to damage control and maintenance of divisional spaces as may be directed by the division leading petty officer, the division officer, the fire marshal, and the DCA.

DAMAGE CONTROLMAN

As a Damage Controlman (DC) you will work with damage control daily. During your daily routine, you will work to prevent fires and flooding while accomplishing your regular job. You will inspect and maintain damage control equipment and systems. When you first start out, you will be assigned to the emergency damage control teams. You will be required to familiarize yourself with your ship's systems and all aspects of damage control. Eventually, you will qualify as scene leader for the emergency damage control teams. You will also be expected to help train other personnel in damage control. Although damage control is an ALL-HANDS responsibility, the DC community ensures that damage control readiness is kept at the highest possible level.

PROFESSIONAL DEVELOPMENT

We said earlier that damage control covers a wide variety of areas. Training is essential for an effective emergency party. This training is accomplished in several ways. You may learn through schools, correspondence courses, on-the-job training, shipboard training lectures and films. Whichever method is used, training will help you become an asset in the damage control field. These methods of training are explained below.

NAVY SCHOOLS

There are a number of Navy schools to train personnel in damage control. Your DCA normally requests quotas to send a complete repair party to a school as a unit. Members of the repair parties train together and learn to work as a unit. These schools include shipboard damage control, shipboard fire fighting, and aviation fire fighting. Refer to the *Catalog of Navy Training Courses (CANTRAC)*, NAVEDTRA 10500, for the latest listing of courses available.

CORRESPONDENCE COURSES

There are a number of correspondence courses available to help you learn damage control. The correspondence course that goes with this manual is mandatory for all DCs. There are two other recommended courses that are not mandatory, but are a good source of training; *Practical Damage Control*, NAVEDTRA 10936, is an officer-enlisted course. It covers damage control equipment, systems, and procedures. *Theoretical Damage Control*, NAVEDTRA 10937, is an officer course that deals with ship's stability. This course is recommended for those assigned as locker leader for a repair party.

ON-THE-JOB TRAINING

Another method of training is on-the-job training. This method allows you to learn while performing your daily tasks. Your fellow workers may teach you by sharing with you their knowledge. Otherwise, you may learn on your own through your experiences and by studying various publications.

You should have access to the manufacturers' technical manuals for your equipment. These manuals will give you information on the operation, maintenance, and repair of the equipment. Use them whenever you work on a piece of equipment that is new to you.

In addition, there are 16 single-subject training manuals available. These booklets contain basic information on the operation of equipment and systems. You may find a listing of these manuals in the *List of Training Manuals and Correspondence Courses*, NAVEDTRA 10061.

On-the-job training is also carried out through emergency drills. These drills help train emergency party personnel to perform their assignments in a professional manner. The drills also train individuals to work together as an effective unit.

You will also have training lectures and films on damage control. These films are listed in the *Department of the Navy Catalog of Audiovisual Production Products*, OPNAVINST 3157.1. The training films are good training tools, especially for views of realistic situations. One film shows an actual fire being fought on an aircraft carrier. The people in the films are not actors; they are sailors combating a casualty. The personnel casualties are real. These films will show that damage control is serious business and an all-hands responsibility.

SOURCES OF INFORMATION

There are several sources of information that you will find valuable when working with damage control. These sources of information include the *Naval Ships' Technical Manuals*, your ship's Damage Control Book, Repair Party Manual, and the Ship's Information Book. You should become familiar with each of these publications.

Naval Ships' Technical Manual (NSTM)

A complete set of *Naval Ships' Technical Manuals* should be available in the engineering log room. Several volumes of these manuals cover different aspects of damage control. These include fire fighting, flooding, ship's stability, and CBR countermeasures. These manuals will help you complete your damage control personnel qualification standards.

Damage Control Book

Damage control books are furnished to all naval ships over 220 feet long and to some select smaller ships. Ships under 220 feet long that are not issued a damage control book may develop their own. These books contain descriptive information, tables, and diagrams. Each book is pertinent to an individual ship. The information given covers the following areas and systems:

1. Damage control systems
2. Ship's compartmentation
3. Ship's piping systems
4. Ship's electrical systems
5. Ship's ventilation systems
6. General information

Naval Sea Systems Command (NAVSEA) maintains a record of all Damage Control Books distributed. The books may not be transferred without NAVSEA authorization. The engineer officer is normally the custodian of the Damage Control Books. Upon transfer, this officer must account for all copies before passing custody to the relieving officer.

You may requisition additional books with diagrams lithographed in color from the Naval Supply Depot, Philadelphia. Books with black-and-white diagrams should be requested from the planning yard of the ship. Copies of the Damage Control Book should be available in DC central, main engine control, and each repair party locker.

It is important to keep all copies of the ship's Damage Control Book up to date. One copy should be considered the "master copy" and be kept current at all times by the DCA. The master copy is then used to update the other copies. The NSTM chapter 079, volume 2 contains the guidelines for updating a Damage Control Book. These changes include alterations completed by the ship's force and those completed by other activities. When the ship is decommissioned and scheduled for disposal or scrapping, the Damage Control Books should be burned and their disposition reported to NAVSEA.

Repair Party Manual

The type commander is responsible for the preparation of a standard repair party manual for ships under his authority. The repair party manual provides detailed information on the standard methods and techniques used in damage control as outlined in the NWP 62-1. A standard repair party manual may include the following information:

1. A listing of the important features of each repair party area, including machinery, storage spaces, location of repair lockers, and magazines
2. Protective measures involving material and personnel with respect to imminent air attack, surface attack, underwater attack, fire, collision, and CBR attack
3. Methods of investigating damage; necessary precautions and means of reporting damage
4. Use of equipment for the following purposes:

    a. Fire fighting
    b. Flooding control
    c. Repairing damage in action (shoring, pipe patching and so forth)
    d. Controlling of CBR contamination (monitoring, reporting, and decontamination of material)

e. Personnel casualty control (first aid and decontamination)

f. Primary and alternate methods of providing emergency service to vital systems by means of casualty power, emergency communications, and jumpers to restore firemain or magazine sprinkling service

5. Damage control central (DCC) location, equipment installed, communications, and personnel

6. Chain of command diagram

7. Secondary DCC description

8. Repair parties—personnel billets, including duties, functions, and responsibilities; subunits (where applicable); and required publications, plates, plans, and diagrams

The repair party manual should include damage control procedures covering emergency damage control communications, casualty power, and counterflooding (where applicable). Door and hatch locations, air-conditioning and ventilation systems, and compressed air systems are also included.

Charts, diagrams, or detailed listings of fittings are not required in the type repair party manual. Such information is available in other publications. One of these is the NAVSEA Damage Control Book, which should be available at every repair party locker.

Commanding officers, with the assistance of their engineer officers and DCAs, are responsible for ensuring that the standard repair party manual for their ship has only correct, complete, and up-to-date information.

Ship Information Book

When a ship is built for the Navy, the builder prepares a Ship Information Book (SIB). The ship's crew uses the SIB to familiarize themselves with the ship's characteristics. Normally the SIB will contain the following eight volumes:

1. Hull and Mechanical
2. Propulsion Plant
3. Auxiliary Machinery, Piping, Ventilation, Heating, and Air-Conditioning Systems
4. Power and Lighting Systems
5. Electronic Systems
6. Interior Communications
7. Weapons Control Systems
8. Ballasting Systems

A copy of the SIB is forwarded to NAVSEA. Then NAVSEA prints and distributes copies of the SIB to the appropriate locations. When changes are made to the ship, corrections to the SIB should be sent to NAVSEA. NAVSEA will incorporate the corrections, and reprint and distribute the SIB.

PERSONNEL QUALIFICATION STANDARDS (PQS)

The General Damage Control Qualification Standard, NAVEDTRA 43119-2, is mandatory for all hands. You should also be familiar with the following damage control qualification standards.

1. *Damage Control Emergency Parties Qualification Standard*, NAVEDTRA 43119-3
2. *Damage Control Systems and Equipment Qualification Standard*, NAVEDTRA 43119-4
3. *Division Damage Control Petty Officer (DCPO) Qualification Standard*, NAVEDTRA 43119-5
4. *Conflagration Station Operator Qualification Standard*, NAVEDTRA 43119-6

You will be assigned to a repair locker for general quarters and an in-port emergency party. You will be required to complete the appropriate sections of PQS that cover your assignments. You should try to complete all sections up to and including the section on Repair Party Scene Leader. In doing so, you will gain valuable knowledge in damage control, and, if necessary, you will be capable of taking over as scene leader during an emergency.

As a Damage Controlman, you should understand the Ship's Maintenance and Material Management (3-M) System, along with the supply and inventory control procedures. This knowledge is required for advancement. You will find the necessary information in chapters 7 and 8 of *Military Requirements for Petty Officer Third Class*, NAVEDTRA 10044.

SUMMARY

You have been introduced to damage control in this chapter. We discussed the responsibilities of individual personnel in a ship's DC organization and sources of information for training. The remainder of this manual will cover the equipment, systems, and procedures used in damage control. Remember, damage control is an ALL-HANDS responsibility. However, the DCs maintain the majority of the equipment and systems. As a DC, you will be recognized by your shipmates in other ratings as an expert.

CHAPTER 2

DAMAGE CONTROL ORGANIZATION, INFORMATION, AND COMMUNICATIONS

Damage control is vital to all ships in the Navy. If a ship is damaged in battle or by a fire or storm, the damage needs to be corrected. You need to be organized to do that. This organization is accomplished through assigned jobs, training, instructions, use of diagrams, and efficient communications. In this chapter, we will discuss the damage control organization, ship's diagrams and blueprints, and the various means of communications.

DAMAGE CONTROL ORGANIZATION

The ship's damage control organization is the means by which you can reach the damage control objectives. In fact, organization is the key to all successful damage control. The damage control organization establishes standard procedures for handling various types of damage. It also sets up training in those procedures so that every person will know immediately what to do in each emergency situation.

Both preventive and corrective actions are vital. The prevention of damage requires that all departments carry out these actions:

1. Maintain the established material conditions of readiness
2. Train all departmental personnel in all aspects of shipboard damage control
3. Maintain the ship in the best condition possible to resist damage

To achieve these goals, the ship's damage control organization must be coordinated with other elements of the ship's organization. Therefore, each department must assign specific damage control duties to individuals in each division. This includes the designation of a divisional damage control petty officer (DDCPO). The corrective aspect of damage control requires the damage control battle organization to promptly restore the offensive and defensive capabilities of the ship.

The damage control organization consists of two elements: the damage control administrative organization and the damage control battle organization.

ADMINISTRATIVE ORGANIZATION

The damage control administrative organization is part of the engineering department organization. However, each department has major administrative and preventive maintenance responsibilities. These responsibilities include the planned maintenance covering damage control equipment, systems, and fixtures within the departmental spaces. Each department head is to ensure that damage control PMS assignments are completed and that discrepancies are documented and corrected.

BATTLE ORGANIZATION

The damage control battle organization includes damage control central (DCC), various repair parties, and battle dressing stations. The organization varies somewhat from one ship to another. The difference will depend upon the size, type, and mission of the ship. However, the following basic principles apply to all damage control battle organizations:

1. Ensure that all personnel within the organization are highly trained in all phases of damage control. They should also be trained in the technical aspects of their ratings to assist in the control of damage.

2. Decentralize the organization into self-sufficient units. These units must have communication with each other. They must be able to take corrective action to control the various types of damage.

3. Have one central station (DCC) receive reports from all damage control units. This station

evaluates and initiates those orders necessary for corrective action from a shipwide point of view. This station also reports to, and receives orders from, command control. These reports concern matters that affect the ship's buoyancy, list, trim, stability, watertight integrity, and chemical, biological and radiological (CBR) defense measures.

4. Ensure that damage control units assigned work that is peculiar to a single department are under the direct supervision of one of that department's officers.

5. Provide for relief of personnel engaged in difficult tasks, for battle messing, and for the transition from one condition of readiness to another. Develop procedures to ensure that all relief crews are informed of the overall situation. Continuous and proper action to combat a casualty can therefore be assured.

6. Provide for positive, accurate, and rapid communications between all damage control units. An overall coordination of effort and direction can then be readily accomplished.

7. Provide for a repair party, remotely located from DCC, to assume the functions of DCC in the event that DCC becomes a battle casualty.

The battle station for the damage control assistant (DCA) is in DCC. The primary damage control battle organization units, shown in figure 2-1, are repair parties or teams. Battle dressing stations should be close to the repair parties.

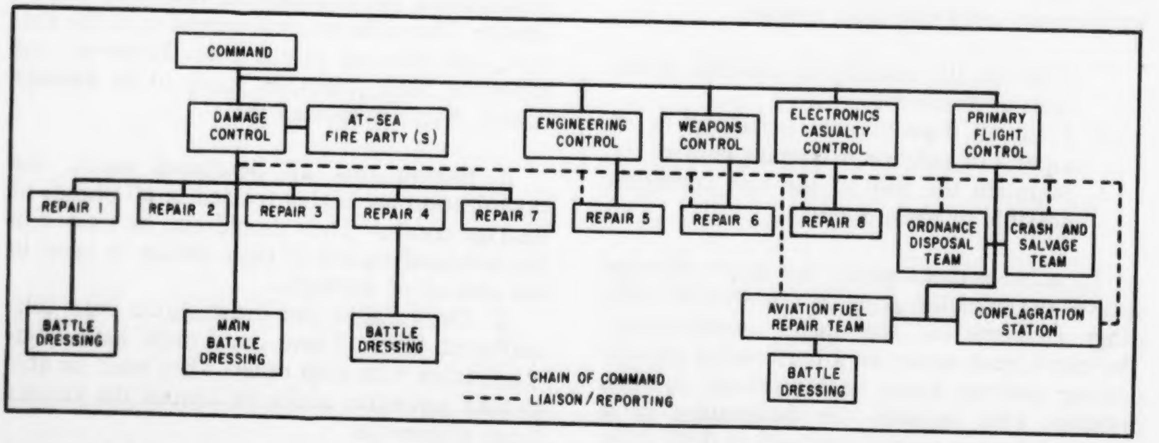
Damage Control Central

Personnel in DCC, under the direction of the DCA, perform the following tasks:

1. Receive and evaluate information from all repair parties.
2. Inform command control of conditions affecting the material condition of the ship, including buoyancy, list, trim, stability, and watertight integrity.
3. Initiate orders to repair parties, as necessary, to direct the control of damage.
4. Keep command control informed of such factors as progress in combating damage, fire, flooding; the effects of CBR attack; and significant personnel casualties. Evaluate the necessity of flooding the magazines that are endangered by fire and recommend corrective action to the commanding officer. Order repair parties to flood the necessary magazines when ordered by the commanding officer.
5. Control watertight integrity, flooding, counterflooding, and dewatering.
6. Maintain the following material as described:

   a. Post and label charts and diagrams to show the subdivisions of the ship and its vital piping and electrical systems.

   b. Post a casualty board in DC central to visually show the damage sustained by the ship and the corrective action in progress. (A simplified schematic is to be maintained on the bridge for


COMMAND
DAMAGE CONTROL
AT-SEA FIRE PARTY (S)
ENGINEERING CONTROL
WEAPONS CONTROL
ELECTRONICS CASUALTY CONTROL
PRIMARY FLIGHT CONTROL
REPAIR 1
REPAIR 2
REPAIR 3
REPAIR 4
REPAIR 7
REPAIR 5
REPAIR 6
REPAIR 8
ORDNANCE DISPOSAL TEAM
CRASH AND SALVAGE TEAM
AVIATION FUEL REPAIR TEAM
CONFLAGRATION STATION
BATTLE DRESSING
MAIN BATTLE DRESSING
BATTLE DRESSING
BATTLE DRESSING
CHAIN OF COMMAND
LIAISON/REPORTING

63.10A

Figure 2-1.—Damage control battle organization.

visual reference by command control on the casualty data reported by DCC.)

c. Post a stability board to show the liquid loading, the location of flooding boundaries, the effect of list and trim caused by flooded compartments, and the corrective action taken with regard to stability. A liquid loading and flooding effects diagram is normally used for this purpose.

d. Prepare a list of access routes for ready shelters, deep shelters, electronic casualty control, and battle dressing stations.

e. Prepare graphic displays to show what action was taken to correct damage control systems and electrical systems.

f. Prepare deck plans to show the areas contaminated by CBR agents; show the locations of, and safe routes to, battle dressing stations and decontamination stations.

g. Prepare a closure log to show the state of closure of the ship.

h. Prepare a CBR contamination prediction plot.

Repair Parties and Teams

Repair party officers should take charge of activities in their area of responsibility after damage is sustained. They should keep DCC informed of the situation. There are certain repair parties that may be subdivided to provide adequate protection for large areas. Sometimes prescribed functions may be the joint responsibility of two or more repair parties. When repair parties are subdivided, they are designated by the number of the parent party followed by a letter (such as 1-A, 1-B). Table 2-1 summarizes the repair parties and teams required by various types of ships.

COMPOSITION.—The composition of the repair parties must permit each party to handle the damage and casualties that occur within its assigned area. Each ship must designate a repair party as secondary DCC. Also, a complete succession for command of damage control will be promulgated and posted in each repair locker. The physical location of each repair locker, the seniority of each repair locker officer, and the communication facilities available should be considered when succession of command is designated. The following general composition is considered necessary.

Repair 1 (Main Deck Repair Party).—An officer or chief petty officer from a deck division is in charge. This repair party is made up of deck division petty officers and nonrated personnel, Storekeepers, Radiomen, Electrician's Mates, Hospital Corpsmen, and aviation details (except in aircraft carriers). Some engineering petty officers may also be required.

The hangar deck officer is in charge of Repair 1-H, also known as the Hangar Bays Repair Party. Repair 1-H is a subdivision of Repair 1. An officer or chief petty officer is assigned as an assistant for each hangar bay. Repair 1-H is made up of petty officers and nonrated personnel from the aviation ratings. Engineering and deck petty officers may also be required.

Repair 2 (Forward Repair Party).—A suitably trained officer or chief petty officer is in charge. This repair party is made up of petty officers of the deck and engineering departments, Electrician's Mates, Storekeepers, Hospital Corpsmen, and nonrated personnel.

Repair 3 (After Repair Party).—Similar to Repair 2.

Repair 4 (Amidship Repair Party).—Similar to Repair 2.

Repair 5 (Propulsion Repair Party).—An engineering department officer is in charge. This repair party is made up of an electrical officer or senior Electrician's Mate and a broad cross section of personnel within the engineering ratings. In the assignment of personnel to Repair 5, emphasis should be placed on fireroom/engine room takeover qualifications instead of on damage control qualifications.

Repair 6 (Ordnance Repair Party).—An officer or chief petty officer of the weapons department is in charge. This repair party is comprised of Gunner's Mates, Fire Control Technicians, and Electrician's Mates. This party may be divided into forward and after subgroups (6-A, 6-B).

Repair 7 (Gallery Deck and Island Structure Repair).—This repair party is found on aircraft carriers and, when necessary, on other types of ships. A suitably trained officer is in charge. The party is made up of personnel from the air and engineering departments and from other departments when necessary.

Table 2-1.—Repair Parties and Teams

SHIP TYPE	MAIN DECK REPAIR 1	FORWARD REPAIR 2	AFTER REPAIR 3	AMIDSHIP REPAIR 4	PROPULSION REPAIR 5	ORDNANCE REPAIR 6	GALLERY DECK AND ISLAND STRUCTURE REPAIR 7	ELEC-TRONICS REPAIR 8	AVIATION FUEL REPAIR TEAM	CRASH AND SALVAGE TEAM	ORD-NANCE DISPOSAL TEAM	AT SEA FIRE PARTY
Aircraft 1/ Carrier	X	X	X	X 2/	X 2/	X	X	X 3/	X	X	X 8/	X
Battleship * and Cruiser	X	X	X	X 2/	X 2/	X		X 3/	X 4/	X 4/		X
Destroyer and Destroyer Escort		X	X		X			X 3/		X 4/		X
Auxiliary and Other Surface Ships Over 220 Ft.	X 5/	X	X	X 6/	X 7/				X 4/	X 4/	X 9/	X
Auxiliary and Other Surface Craft 220 Ft. or Less	X 7/	X 10/	X 10/		X 7/							X

NOTES:

1/ Pertains to CVA, CVAN, CVS, and LPH.

2/ In certain classes of these ship types, the designation of Repair 4 as "forward propulsion repair" and Repair 5 as "after propulsion repair" results in more effecient use of personnel (see text).

3/ Applies to those types as determined by type commanders and approved by fleet commanders in chief.

4/ Applies to ships equipped for manned helicopter operations.

5/ Large LP types only.

6/ Large new construction auxiliaries. Includes superstructure.

7/ Type commanders may omit Repair 1 and/or 5 in those ships where appropriate.

8/ Applies to ships equipped for armed aircraft operations.

9/ Applies to AE types and LPH 10 and older LPH.

10/ MSO/MSC only.

* When activated

Repair 8 (Electronics Repair Party).—An officer or chief petty officer of the operations department is in charge. This repair party is comprised of Electronics Technicians, Sonar Technicians, Fire Control Technicians, and Electrician's Mates. This repair party works under electronics casualty control.

Aviation Fuel Repair Team and Crash and Salvage Team.—These teams are peculiar to aircraft carriers and to other ships that are equipped for manned helicopter operations. On aircraft carriers, an officer or chief petty officer of the air department is in charge. On aircraft carriers, these teams are made up of air department personnel. On other ships that are equipped for manned helicopter operations, appropriate deck and engineering department personnel are assigned.

Ordnance Disposal Team.—This team is made up of specially trained personnel deployed aboard ships as required. The team is organized within and administered as a unit of the ship's weapons department. The ordnance disposal team normally operates under the direction of the ship's weapons officer.

IDENTIFICATION OF REPAIR PARTY LEADERS.—Damage control repair party leaders are issued a steel helmet (or similar headgear) to wear during damage control actions. The words "damage control party leader" are intended to be synonymous with repair party leader or fire party leader. Helmets/liners worn by damage control party leaders are painted red and bear 1-inch black lettering on the front and back, identifying the particular damage control repair party (R-2, R-5). Three 1-inch horizontal stripes of reflective tape, alternating white-red-white, are affixed to the lower circumference of the helmet/liner. No other member of a damage control party may wear a helmet marked in this way, or one that might be mistaken for the leader's helmet.

Repair party personnel whose duties require them to go topside should wear steel helmets. Repair party personnel whose duties are entirely below deck may wear helmet liners instead of steel helmets.

Steel helmets are not authorized on flight decks and hangar decks of aircraft carriers, and on other ships operating with helicopters or fixed-wing aircraft. Accordingly, flight deck helmets are substituted for the steel helmet where appropriate. A DC party leader's helmet is marked as indicated above. The DC party leader's red jersey is stenciled with the words "Crash/Salvage Leader."

New nonmetallic fire-retardant helmets are being introduced into the fleet. These helmets will replace the steel helmets currently worn by repair party and fire party personnel. The new design will increase ballistic protection and prevent electrical shock. The fire fighter's helmet has a facial visor and will provide neck and throat protection. A ballistic facial shield is also being introduced. It will attach to the phone talker's helmet and the battle helmet. It can be worn with the Mk-5 gas mask and provides face and throat protection.

GENERAL FUNCTIONS OF REPAIR PARTIES.—General functions of repair parties require close coordination between the parties. The following functions are common to all repair parties.

1. Repair electrical and sound-powered telephone circuits.
2. Give first aid to injured personnel and then transport them to battle dressing stations without seriously reducing the damage control capabilities of the repair party.
3. Detect, identify, and measure dose and dose-rate intensities from radiological involvement. Survey areas and personnel; decontaminate those that receive radiological contamination.
4. Obtain samples of biological agents to be sent to a laboratory for identification. Ships do not have the capabilities to identify biological agents. Identify the chemical agents used. Decontaminate areas and personnel affected by biological or chemical attack.
5. Control and extinguish all types of fires.
6. Evaluate and report correctly the extent of damage in their areas. This includes maintaining the following:
    a. A graphic display board showing damage and action taken to correct disrupted or damaged systems.
    b. Deck plans showing locations of CBR contamination and locations of, and safe routes to, battle dressing and personnel decontamination stations.
    c. A casualty board for visual display of structural damage.

SPECIFIC FUNCTIONS OF REPAIR PARTIES.—The following specific functions are the responsibilities of the repair parties indicated.

1. Repair 1, 2, 3, 4, and 5 will maintain the stability and buoyancy of the ship as follows:

a. Station themselves to reach all parts of the ship while opening a minimum of watertight closures.

b. Repair damage to structures, closures, or fittings that maintain watertight integrity. Shore, plug, weld, and caulk the bulkheads and decks; reset valves; and blank or plug lines through watertight subdivisions of the ship.

c. Sound, drain, pump, counterflood, or shift liquids in tanks, voids, or other compartments when necessary. Be familiar with the methods used to transfer liquids from one location to another and the equipment used for that purpose.

d. Maintain two status boards for accurate evaluation of underwater damage. The Stability Status Board (Flooding Effects Diagram) is a visual display of all flooding, flooding boundaries, corrective measures taken, and effects on list and trim. The Liquid Load Status Board shows the current status of all fuel and water tanks and the soundings of each tank in feet and inches.

2. Repair 1, 2, 3, and 4 will maintain the ship's structural integrity and maneuverability as follows:

a. Repair primary and auxiliary methods of steering.

b. Clear the upper decks of wreckage that interferes with the operation of the battery, ship, or fire control stations. Clear wreckage that fouls the rudder, propellers, or sides of the ship. Extinguish all types of fires.

c. Maintain and make emergency repairs to battle service systems. These systems include ammunition supply, ventilation supply, high- and low-pressure air lines, communications systems, electrical systems, and cooling water systems.

d. Provide emergency power to vital electrical equipment, using casualty power cables.

e. Assist the crash and salvage team as required.

f. Stream and recover minesweeping equipment during general quarters.

g. Rescue survivors from the water, and render assistance to other ships when required.

h. Repair damage above the water line that could cause flooding in the event of further damage.

3. Repair 5 will maintain the ship's propulsion equipment as follows:

a. Maintain and make repairs, or isolate damage, to main propulsion machinery and boilers.

b. Operate, repair, or isolate vital systems. Modify the methods of segregating vital systems when necessary.

c. Assist in the operation and repair of the steering control systems.

d. Assist in the maintenance and repair of communications systems.

e. Assist Repair 1, 2, 3, and 4 and the crash and salvage team when required.

4. Repair 6 will protect ordnance and magazines as follows:

a. Make emergency repairs to all ordnance installations, including the supply and renewal of parts.

b. Operate the magazine sprinkler systems and other ordnance systems.

c. Assist other repair parties in extinguishing fires in the vicinity of magazines.

d. Assist other repair parties in making hull damage repairs.

e. Station repair party control at the forward magazine sprinkler control station. Maintain communications with weapons control, DCC, and its own detached units.

f. Isolate those magazines to be sprinkled from others in the same group.

g. Notify DCC of the sprinkling/flooding of magazines. (The magazines are NOT to be flooded unless authorized by the commanding officer.)

5. Repair 1 and its subdivisions will maintain the main deck and hangar bays in aircraft carriers as follows:

a. Control and extinguish fires.
b. Repair damage in assigned areas.

6. Repair 7 will maintain the gallery decks and island structure in aircraft carriers as follows:

a. Control and extinguish fires.
b. Repair damage in assigned areas.

7. Repair 8 will maintain electronics equipment on selected ships. On ships with highly complex electronic weapons systems, such as

missile ships and large aircraft carriers, Repair 8 will meet its responsibilities as follows:

a. Repair radar, radio, countermeasures, and all associated electronics equipment.
b. Repair fire control equipment.
c. Repair sonar equipment.
d. Extinguish minor electrical fires.

8. The aviation fuel repair team will maintain the aviation fuel systems as follows:

a. Operate, maintain, and repair all aviation fuel systems.
b. Extinguish fires.

9. The crash and salvage team will maintain the flight deck and hangar deck as follows:

a. Extinguish aircraft fires, rescue pilots promptly, and conduct aircraft salvage operations on the flight deck.
b. Make repairs of all types to the flight deck and associated equipment.
c. Make repairs of all types to the hangar deck and associated equipment.

10. The weapons officer is responsible for maintaining protection of exposed ordnance. The air officer is responsible for this function during flight quarters on the flight and hangar decks. Their principal assistance for this function comes from the ordnance disposal team. This team will meet its responsibilities as follows:

a. Remove ordnance from aircraft on fire, or at any time required.
b. Safely jettison ordnance as necessary to prevent damage to the ship.

SPECIAL ORGANIZATION OF REPAIR PARTIES.—Special organization, with regard to stations and functions, is described below for specific types of ships.

Repair 5 may be split on large ships. Each half of the party is assigned one-half of the engineering plant. This arrangement allows for maximum use of manpower and equipment and for greater dispersal of personnel. However, each section of the repair party must be assigned a sufficient number of qualified engineering casualty control and damage control personnel.

The functions of Repair 5 are assigned to the appropriate repair party designated by the type commander on small ships that do not have a Repair 5 (see table 2-1).

The aviation fuel repair team and the crash and salvage team may be combined in small carriers. They may also be incorporated into existing repair parties on ships equipped for manned helicopter operations.

Battle Dressing Stations

Most ships have a minimum of two battle dressing stations equipped for emergency handling of personnel battle casualties. However, many smaller ships, such as minesweepers, have only one such station. Those ships having two or more battle dressing stations should have the stations well separated from each other. Each battle dressing station must be accessible to the stretcher bearers from repair parties within the vicinity. Each battle dressing station should be manned by medical department personnel as assigned by the senior member of that department. First-aid kits or boxes are available at battle stations as well as battle dressing stations. The medical department furnishes the material for these first-aid kits and boxes.

At-Sea Fire Party

Most surface ships have organized a special fast-response fire party, known as the at-sea fire party. This party is also referred to as the Flying Squad. It may be a standing organization or part of a special detail organized for special evolutions. These special evolutions include weapons handling, underway replenishment, helicopter operations, and towing operations. The at-sea fire party will carry out the following responsibilities:

1. Respond immediately to fire alarms when the ship's repair parties are not manned.
2. Extinguish small fires without disrupting other ship operations.
3. Control fires until ongoing sensitive critical evolutions can be secured and general quarters stations can be manned and ready.

Where appropriate, an at-sea fire party may also perform the duties of a helicopter fire party in accordance with NWP 42.

The at-sea fire party may be incorporated intact into the general quarters damage control organization. It may be a repair party or unit, or it may be composed of members of various repair parties, as manning permits.

NUMBER OF MEN	FUNCTION/PROVIDE
1	Scene Leader
2	Investigator -- OBA
2	OBA Tenders -- Kit
2	Nozzleman -- OBA
2	Hoseman -- Foam Cans
2	Plugman -- CO_2 Bottles
1	Talker -- Sound-Powered (2JZ) Phones
1	Messenger -- Message Forms
1	Electrician -- Kit, OBA
1	Corpsman -- Kit
X	Aircraft Fire Fighters, as appropriate

Figure 2-2.—At-sea fire party organization.

The at-sea fire party will respond to all fires at sea, except when the ship is already at general quarters. If a fire breaks out and the fire alarm is sounded, immediately followed by the general alarm, the at-sea fire party will continue to respond to the fire. When general quarters stations have been manned, the appropriate repair party will relieve the at-sea fire party at the scene.

The at-sea fire party will normally consist of the personnel listed in figure 2-2. Variations are authorized, if required by a particular ship. The DCA is responsible for the organization and training of the at-sea fire party.

In-Port Fire Party

The in-port fire party will function as a repair party while the ship is in port. CBR defense operations are not a normal evolution for an in-port fire party. However, this fire party should still be prepared to handle any incident. There is always a possibility of an accident involving a nuclear weapon or a nuclear reactor. Also, civilian chemical plants have had tanks explode, discharging the contents into the atmosphere. But for the most part, the in-port fire party will normally be concerned with fires and flooding.

The duty in-port fire party organization will vary from one ship to another. The number of personnel assigned to this fire party will depend upon the number available in each duty section. Some ships have enough personnel to stand six-section duty and maintain an effective duty in-port fire party. Other ships may be required to remain in a four-section duty status to maintain an effective duty in-port fire party. The minimum acceptable duty in-port fire party manning requirements are shown in figure 2-3.

No two emergency situations are identical. Therefore, the corrective action taken will vary to some extent. The responsibilities of each member of the fire party will normally remain the

FIRE DUTIES	COLLISION/FLOODING DUTIES
(1) DCC Supervisor/Locker Leader	DCC Supervisor/Locker Leader
(2) On-Scene Leader	On-Scene Leader
(3) #1 Nozzleman	Investigator
(4) #2 Nozzleman	Assistant Investigator
(5) #1 Hoseman	Shoring Detail
(6) #2 Hoseman	Pump Detail
(7) #1 Plugman	Shoring Detail
(8) #2 Plugman	Shoring Detail
(9) Electrician	Electrician
(10) Accessman/Compartment Tester	Pump Detail
(11) Stretcher Bearer	Stretcher Bearer
(12) Boundary Setter	Boundary Setter
(13) Boundary Setter	Boundary Setter
(14) CO_2 Man	Pump Detail
(15) Foam Man	Pump Detail
(16) Sprinkleman	Pump Detail
(17) DCC/Repair Locker Phone Talker	DCC/Repair Locker Phone Talker
(18) On-Scene Phone Talker	On-Scene Phone Talker

Figure 2-3.—Minimum acceptable duty in-port fire party assignments.

same. However, there are times when a person will have to assume other responsibilities. As an example, the No. 1 nozzleman is injured while fighting a fire. The No. 1 hoseman then takes the No. 1 nozzleman's place. The No. 1 nozzleman is evacuated from the scene and another person replaces the No. 1 hoseman. The responsibilities of some personnel remain the same for fires, collisions, and flooding. However, you do not need a fire fighter in a compartment that is completely flooded. So the assignments of the nozzlemen, hosemen, and some other personnel will change to accommodate the emergency situation at hand.

The following information is a brief description of the responsibilities and requirements of various key fire party personnel. The equipment mentioned in this section will be discussed in more detail later in this training manual.

DCC SUPERVISOR/LOCKER LEADER.—The DCC supervisor assumes overall charge of the in-port fire party. This person is normally a chief petty officer or a junior officer. (On ships where a DCC supervisor is not assigned, the locker leader assumes the overall charge of the in-port fire party.) The supervisor stays in the vicinity of the repair locker or DCC during all emergency evolutions. As the person in charge, the supervisor organizes and trains the fire party to work effectively as a team in combating any situation that arises. The supervisor must also analyze and evaluate any situation and provide information and guidance to the on-scene leader by message. The DCC supervisor will have schematics of various ship's systems and the ship's compartmentation available. These are helpful to persons who plot damage reports and provide guidance to the on-scene leader.

The DCC supervisor should be qualified as an on-scene leader, an investigator, a fire fighter, a DC repairman, and in CBR evaluation. An investigator is normally a collateral duty of the nozzleman. However, all personnel on a fire party should complete their PQS for investigator, nozzleman, and hoseman. DC repairmen should be qualified in shoring, dewatering, desmoking, and making temporary repairs. Temporary repairs are normally made to piping, bulkheads, the hull, and other structural members of the ship.

ON-SCENE LEADER.—The on-scene leader is the person in charge of the fire party at the scene. To qualify for the job of on-scene leader, you must complete the appropriate PQS. Once assigned the job, you will direct all efforts of the fire party to combat the emergency situation. You will report to the DCC supervisor, using DC message blanks and sound-powered telephones. All other personnel on the fire party will report directly to you. To qualify as an on-scene leader, you should be qualified as an investigator, a fire fighter, and a DC repairman.

NO. 1 NOZZLEMAN.—As the No. 1 nozzleman, you will man the attack hose nozzle. You will be in charge of the fire team that enters the compartment to extinguish the fire. For your protection, you will be required to wear an OBA. Once the fire is extinguished, you will order the backup hose to be pulled back to the entrance of the space and the reflash watch set. Then you will use your personnel available inside the compartment to overhaul the fire, conduct atmospheric tests, desmoke the compartment, and investigate the damage. When conducting atmospheric tests, you will have the accessman/compartment tester check the space for the percentage of oxygen content and the presence of explosive and toxic gases. (The duties of the accessman/compartment tester will be explained later in this section.) You should be qualified in first aid, the operation of all fire-fighting equipment, and the procedures for overhauling a fire.

In the event of a collision or flooding, you will act as an investigator. Here you will check for heat, smoke, flames, fumes, parted electrical cables, leaking pipes or seams, visual damage, and any other unusual condition. Do the initial investigation quickly but thoroughly. You will then report to the on-scene leader. The on-scene leader will then have you make a slower, more detailed investigation. Investigators should be qualified in investigation procedures, making damage reports, use of the legend system, and fire fighting.

NO. 2 NOZZLEMAN.—As the No. 2 nozzleman, you will man the back up hose nozzle with an applicator attached to it. Your task is to provide protection for yourself and the No. 1 nozzleman. You do this by maintaining a low-velocity water screen between yourselves and the flames. After the fire is out, you will help the accessman/compartment tester conduct the atmospheric tests. Until the compartment is determined to be safe to enter, only persons wearing an OBA may enter the space. Your qualifications are the same as those for the

No. 1 nozzleman. You will help the No. 1 nozzleman conduct investigations in the event of a collision or flooding.

NO. 1 HOSEMAN.—As the No. 1 hoseman, you will have several duties. You will wear an OBA. You will run the attack hose from the fire plug to the scene, and you will keep the hose from getting fouled while fighting the fire. The No. 1 nozzleman will be able to handle the hose and nozzle better if you keep the weight and tension of the hose off the No. 1 nozzleman. Your other duties include the relaying of spoken messages and orders between the on-scene leader and the No. 1 nozzleman. You will assume the duties of the reflash watch when directed to do so. After the fire is out, overhauled, and the space is safe to enter, you will help clean up the compartment.

In the event of a collision or flooding, you will be on the shoring detail. There you will reinforce weakened bulkheads, brace warped watertight closures, and patch holes in bulkheads and piping. Shoring, plugging, and patching procedures will be discussed in a later chapter.

NO. 2 HOSEMAN.—As the No. 2 hoseman, you will wear an OBA and have duties similar to those of the No. 1 hoseman. You will run the backup hose from the fire plug to the scene. Ensure that the appropriate applicator is installed in the nozzle. While fighting the fire, keep the hoses from getting fouled. Also, the No. 2 nozzleman can handle the hose and nozzle better if you keep the weight and tension of the hose off the No. 2 nozzleman. Your other duties are to relay spoken messages and orders between the on-scene leader and the No. 1 nozzleman. When directed, you will assist in the overhaul of the fire and any other action required.

In the event of a collision or flooding, you will be part of the pump detail. The pump detail transports the dewatering equipment to the scene and sets it up. Once the equipment is on the scene and rigged, notify the on-scene leader. The on-scene leader will tell you when to activate your equipment. As a No. 2 hoseman, you should be able to operate all types of dewatering equipment and to troubleshoot problems that arise.

NO. 1 PLUGMAN.—As the No. 1 plugman, you will connect the hose to the fire plug. When directed to do so, and while the nozzle is closed, open the fire plug valve to activate the hose. You will need to keep an eye on the hose for loss of water pressure or a hose rupture. If there is a loss of water pressure, flush out the marine strainer by using the strainer lever. In the event of a ruptured fire hose, secure the fire plug, replace the ruptured section of hose, and reactivate the hose as quickly as possible. In the event of a collision or flooding, you will be assigned to the shoring detail.

NO. 2 PLUGMAN.—As the No. 2 plugman, you will connect the backup hose to the fire plug. Your duties are the same as those of the No. 1 plugman. In the event of a collision or flooding, you will also be assigned to the shoring detail.

ELECTRICIAN.—When there is fire or flooding, the repair party electrician will immediately secure electrical power to all compartments that are affected by the casualty. The electrician will report to the on-scene leader when the electrical power is secured. The electrician is responsible for the plugging in, energizing, and de-energizing of the electrical submersible pumps, red devil blowers, and any other electrical equipment required. Other members of the fire party may set up the equipment for use; however, they are not to plug in, energize, or de-energize the equipment. Once the casualty is corrected, the electrician will investigate the compartments for electrical damage when directed to do so by the on-scene leader. The electrician will complete repairs to vital electrical systems as soon as possible. Repairs to nonvital electrical systems will be completed as time allows.

ACCESSMAN/COMPARTMENT TESTER.—If you are assigned as the accessman/compartment tester, you will have dual responsibilities. First, you will provide forcible-entry tools at the scene. Second, you will provide the compartment atmosphere-testing devices. When the hose teams are ready to enter a space, you will open the door, hatch, or scuttle. If the space is locked, you will have to decide which forcible-entry tools to use. There are times when you have to clear a route so that the fire party can gain access to the fire.

Once entry has been made, you will stand by to assist where needed until the on-scene leader orders you to test the atmosphere within the compartment. When conducting the tests, you will operate the test equipment from outside the space. A hoseman or nozzleman with the sensor probe or sampling hose will move about the compartment being tested. These tests are used to check for explosive gases, toxic gases, and sufficient oxygen content to sustain life. In the event of a collision or flooding, you will be on the pump detail.

STRETCHER BEARER.—If you are assigned as a stretcher bearer, you will be required to take the repair locker first-aid kit, or box, to or near the scene. If medical department personnel are available, you will help them in administering first aid, as required. In the absence of medical department personnel, you will render basic first aid and then assist in the evacuation of injured personnel to battle dressing stations.

BOUNDARY SETTER.—There are two boundary setters assigned to a fire party. One is responsible for setting the forward boundaries while the other is responsible for setting the aft boundaries. Fire/flooding boundaries are set to contain a casualty within the smallest area possible. In other words, a fire should be confined to one compartment if possible. Flooding should be confined to keep it from progressing and seriously affecting the ship's stability. The forward and after bulkheads of a compartment are normally used as the fire boundaries.

When acting as boundary setter during a fire, you will need a means to keep the bulkheads and decks cool. A fire hose is normally used if available. Otherwise, you may use a bucket of water and a swab. You will also need to move all combustibles away from the bulkhead that is adjacent to the fire, if possible.

In the case of flooding, the first set of watertight transverse bulkheads forward and aft of the flooded compartment are used as the flooding boundaries. While acting as boundary setter during flooding, you will have to keep a watchful eye on the situation. If a closure or seam begins to leak or if the bulkhead starts panting, report it to the on-scene leader.

CO_2 MAN.—As the person in charge of CO_2, you will provide portable CO_2 fire extinguishers to the scene. Persons wearing the OBAs will use the CO_2 extinguishers to fight electrical fires. The number of extinguishers required will vary depending on the size of the fire. However, a minimum of two extinguishers are to be provided. In the event of a collision or flooding, CO_2 bottles will not be required initially. Therefore, you will assist the accessman on the pump detail.

FOAM MAN.—As the foam man, you will be responsible for the operation of the aqueous film forming foam (AFFF) stations and equipment. If the fire's location is not protected by an installed AFFF system, you will deliver two cans of foam to the location of the portable foam-producing equipment. You might be required to obtain additional AFFF to fight a class BRAVO fire. In the event of a collision or flooding, you will be assigned to the pump detail. Chapter 5 will discuss the AFFF systems.

SPRINKLEMAN.—A Gunner's Mate is normally assigned as the sprinkleman. The sprinkleman will stand by the appropriate magazine sprinkling control station in the event that an order is given to activate the system. The sprinkleman informs the on-scene leader when a magazine control station is manned. In the event of a collision or flooding, the sprinkleman will assist the pump detail.

DCC/REPAIR LOCKER PHONE TALKER.—If you are assigned as the DCC/repair locker phone talker, you will report to DCC or the repair locker. There you will man the phone between the DCC supervisor and the on-scene leader. You will receive messages from the on-scene leader, via the on-scene phone talker, and relay them to the DCC supervisor. You will relay all messages from the DCC supervisor to the on-scene phone talker.

ON-SCENE PHONE TALKER.—If you are assigned as the on-scene phone talker, you will man the phone at the scene. Here you will receive messages from the DCC supervisor, via the DCC phone talker, and relay them to the on-scene leader. You will also relay all messages from the on-scene leader to the DCC phone talker.

MESSENGER.—If you are assigned as the messenger, you will be responsible for carrying messages between the on-scene leader and the DCC supervisor. You will need to be thoroughly familiar with your ship and know how to get from one place to another. You are to stay near the on-scene leader at all times except when you are taking a message to the DCC supervisor. When you are carrying a message from one point to another, do so quickly. The on-scene leader may have another message ready for you when you get back.

DIAGRAMS AND BLUEPRINTS

As a Damage Controlman, you will often use various shipboard diagrams and blueprints. The ship's plans (blueprints) and isometric damage control diagrams are the drawings that you will

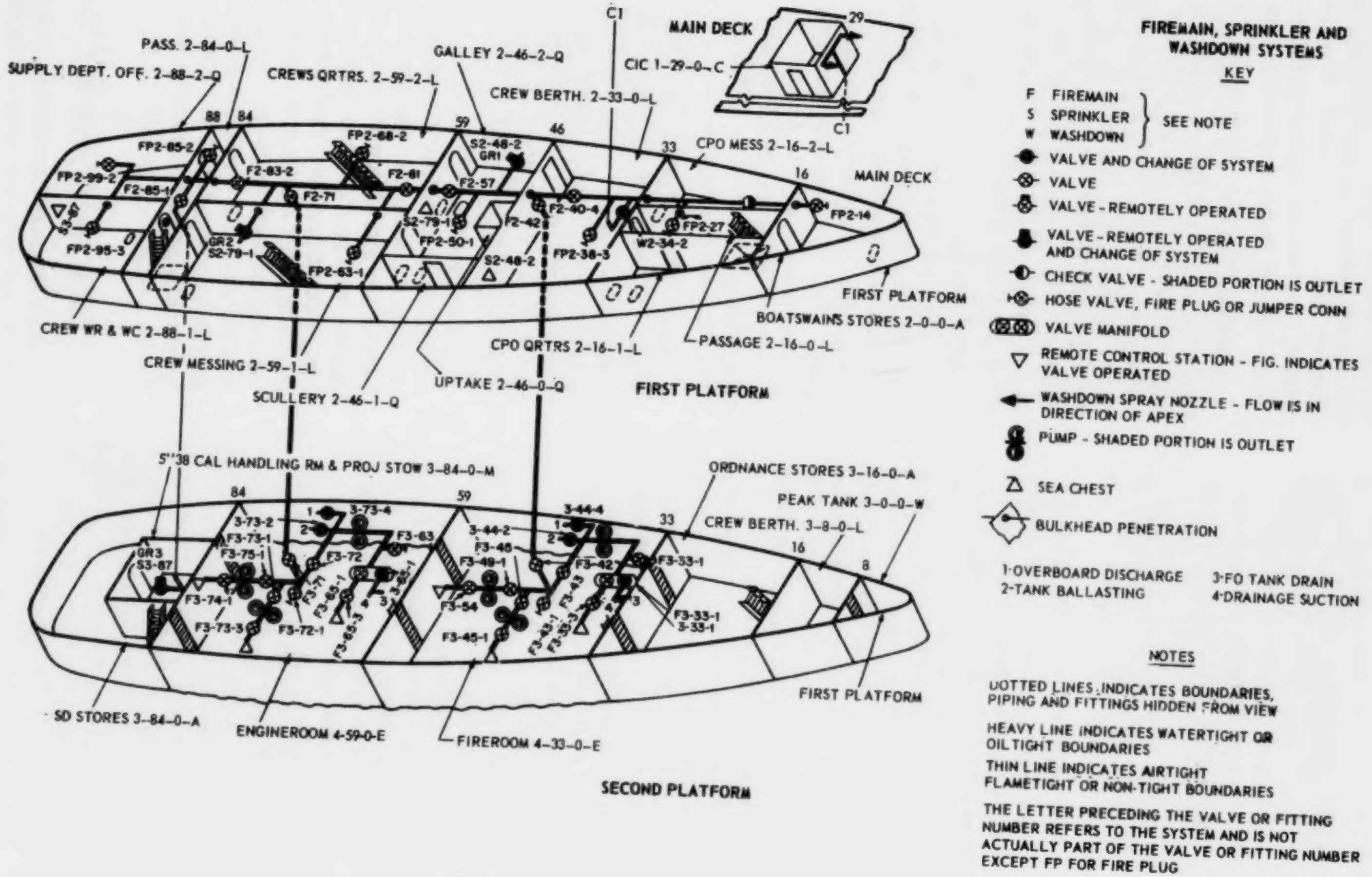

C1
MAIN DECK
29
CIC 1-29-0-C
C1
PASS. 2-84-0-L
SUPPLY DEPT. OFF. 2-88-2-Q
CREWS QRTRS. 2-59-2-L
GALLEY 2-46-2-Q
CREW BERTH. 2-33-0-L
CPO MESS 2-16-2-L
MAIN DECK
88
84
59
46
33
16
FP2-85-2
FP2-99-2
F2-85-1
FP2-95-3
F2-83-2
F2-71
FP2-68-2
F2-61
S2-48-2
GR1
F2-57
S2-79-1
FP2-50-1
GR2
S2-79-1
FP2-63-1
F2-42
S2-48-2
F2-40-4
FP2-38-3
W2-34-2
FP2-27
FP2-14
FIRST PLATFORM
BOATSWAINS STORES 2-0-0-A
PASSAGE 2-16-0-L
CPO QRTRS 2-16-1-L
CREW WR & WC 2-88-1-L
CREW MESSING 2-59-1-L
SCULLERY 2-46-1-Q
UPTAKE 2-46-0-Q
FIRST PLATFORM
5"38 CAL HANDLING RM & PROJ STOW 3-84-0-M
ORDNANCE STORES 3-16-0-A
PEAK TANK 3-0-0-W
CREW BERTH. 3-8-0-L
84
59
33
16
8
1
2
3-73-4
3-73-2
F3-73-1
F3-75-1
F3-72
F3-63
GR3
S3-87
F3-74-1
F3-73-3
F3-72-1
F3-71
F3-65-1
F3-65-3
3
3-44-4
3-44-2
F3-46
F3-49-1
F3-54
F3-45-1
F3-43
F3-42
F3-43-1
F3-33-3
F3-33-1
F3-33-1
3-33-1
SD STORES 3-84-0-A
ENGINEROOM 4-59-0-E
FIREROOM 4-33-0-E
FIRST PLATFORM
SECOND PLATFORM
FIREMAIN, SPRINKLER AND WASHDOWN SYSTEMS
KEY
F FIREMAIN
S SPRINKLER
W WASHDOWN
SEE NOTE
VALVE AND CHANGE OF SYSTEM
VALVE
VALVE - REMOTELY OPERATED
VALVE - REMOTELY OPERATED AND CHANGE OF SYSTEM
CHECK VALVE - SHADED PORTION IS OUTLET
HOSE VALVE, FIRE PLUG OR JUMPER CONN
VALVE MANIFOLD
REMOTE CONTROL STATION - FIG. INDICATES VALVE OPERATED
WASHDOWN SPRAY NOZZLE - FLOW IS IN DIRECTION OF APEX
PUMP - SHADED PORTION IS OUTLET
SEA CHEST
BULKHEAD PENETRATION
1-OVERBOARD DISCHARGE
2-TANK BALLASTING
3-FO TANK DRAIN
4-DRAINAGE SUCTION
NOTES
DOTTED LINES INDICATES BOUNDARIES, PIPING AND FITTINGS HIDDEN FROM VIEW
HEAVY LINE INDICATES WATERTIGHT OR OILTIGHT BOUNDARIES
THIN LINE INDICATES AIRTIGHT FLAMETIGHT OR NON-TIGHT BOUNDARIES
THE LETTER PRECEDING THE VALVE OR FITTING NUMBER REFERS TO THE SYSTEM AND IS NOT ACTUALLY PART OF THE VALVE OR FITTING NUMBER EXCEPT FP FOR FIRE PLUG
8.74

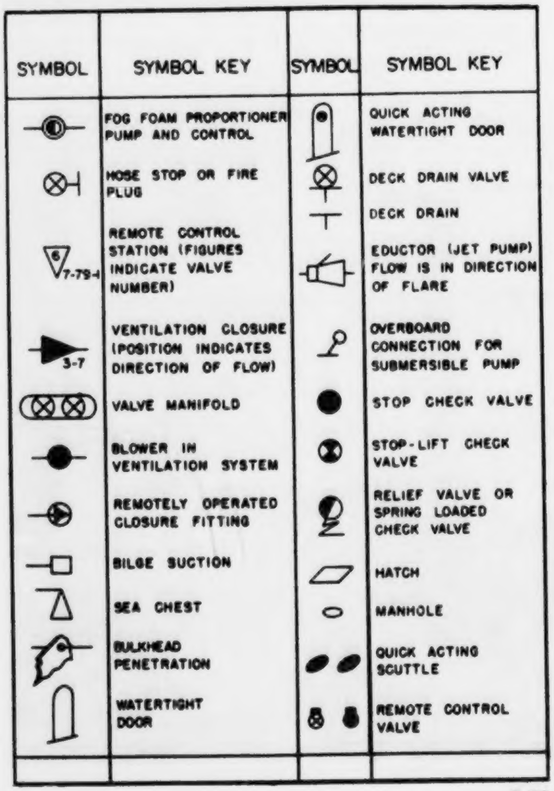
Figure 2-4.—A typical isometric damage control diagram.

use most. To better understand the ship's plans and blueprints, you should complete the correspondence course *Blueprint Reading and Sketching*, NAVEDTRA 10077.

In addition to knowing how to read drawings, you must also know how to locate applicable drawings. The onboard drawings, which are sometimes referred to as ship's plans or ship's blueprints, are listed in the Ship's Drawing Index (SDI). The SDI is kept in the engineering department office (log room).

The SDI lists all working drawings that have a NAVSHIPS or NAVSEA drawing number, all manufacturer's drawings, all equipment drawing lists, and all assembly drawings that list detail drawings. Drawings that are actually kept onboard are identified in the SDI by an asterisk (*).

Drawings are listed in numerical order in the SDI. Two types of numbering systems are in use for drawings that have NAVSHIPS or NAVSEA numbers. The older system (NAVSHIPS) is an S-group numbering system. The newer system is used on all NAVSEA drawings since 1 January 1967.


SYMBOL
SYMBOL KEY
SYMBOL
SYMBOL KEY
FOG FOAM PROPORTIONER PUMP AND CONTROL
QUICK ACTING WATERTIGHT DOOR
HOSE STOP OR FIRE PLUG
DECK DRAIN VALVE
DECK DRAIN
6
7-79-1
REMOTE CONTROL STATION (FIGURES INDICATE VALVE NUMBER)
EDUCTOR (JET PUMP) FLOW IS IN DIRECTION OF FLARE
3-7
VENTILATION CLOSURE (POSITION INDICATES DIRECTION OF FLOW)
OVERBOARD CONNECTION FOR SUBMERSIBLE PUMP
VALVE MANIFOLD
STOP CHECK VALVE
BLOWER IN VENTILATION SYSTEM
STOP-LIFT CHECK VALVE
REMOTELY OPERATED CLOSURE FITTING
RELIEF VALVE OR SPRING LOADED CHECK VALVE
BILGE SUCTION
HATCH
SEA CHEST
MANHOLE
BULKHEAD PENETRATION
QUICK ACTING SCUTTLE
WATERTIGHT DOOR
REMOTE CONTROL VALVE

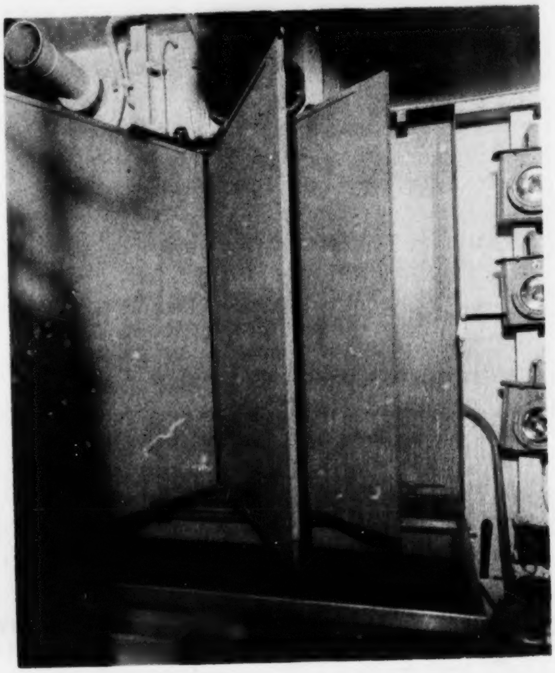
8.73

Figure 2-5.—Some symbols used on damage control diagrams.

The onboard drawings are filed in numerical sequence. On most ships, they are kept in file cabinets in the log room. However, they may be filed in a technical library or the microfilm library on aircraft carriers, tenders, and repair ships.

Although you may use blueprints and drawings for damage control purposes, you will primarily use the isometric damage control diagrams (shown in fig. 2-4). These diagrams are three-dimensional. They are developed and provided under strict requirements set forth by NAVSEA. When NAVSEA furnishes a group of ships their diagrams, the ship's force must verify the diagrams for accuracy. Corrections should be made to show the actual installation within the ship. In order to read these diagrams correctly, you need to recognize the standard symbols used. A few of these symbols are shown in figure 2-5. Each diagram will have a key, which will identify the symbols used on that diagram. As a rule, the different systems are drawn in different colors. This makes it easier to distinguish one system from another.

Isometric damage control diagrams that are not kept in the damage control books are usually sealed in plastic. They are stowed in special cabinets like those in figure 2-6. These cabinets



8.75

Figure 2-6.—Cabinet for isometric damage control diagrams.

and diagrams are located in DCC and in the various repair party lockers.

On the isometric damage control diagrams, each deck or platform is shown at a separate level. Compartments that are not intersected by a particular deck are not shown on the diagram for that deck. Instead, they are drawn as part of the deck from which they extend. Heavy lines indicate watertight and oiltight boundaries. Lighter lines indicate airtight, fumetight, and nontight boundaries.

The isometric damage control diagrams show piping systems as close as possible to their actual shipboard locations. All piping and fittings that are actually contained within a compartment are shown in that compartment on the diagram. However, the precise location may be shifted a little in order to make the diagram clear and readable. Dotted lines and cross-hatchings indicate hidden boundaries, piping, and valves. Usually the isometric damage control diagrams are not drawn to scale.

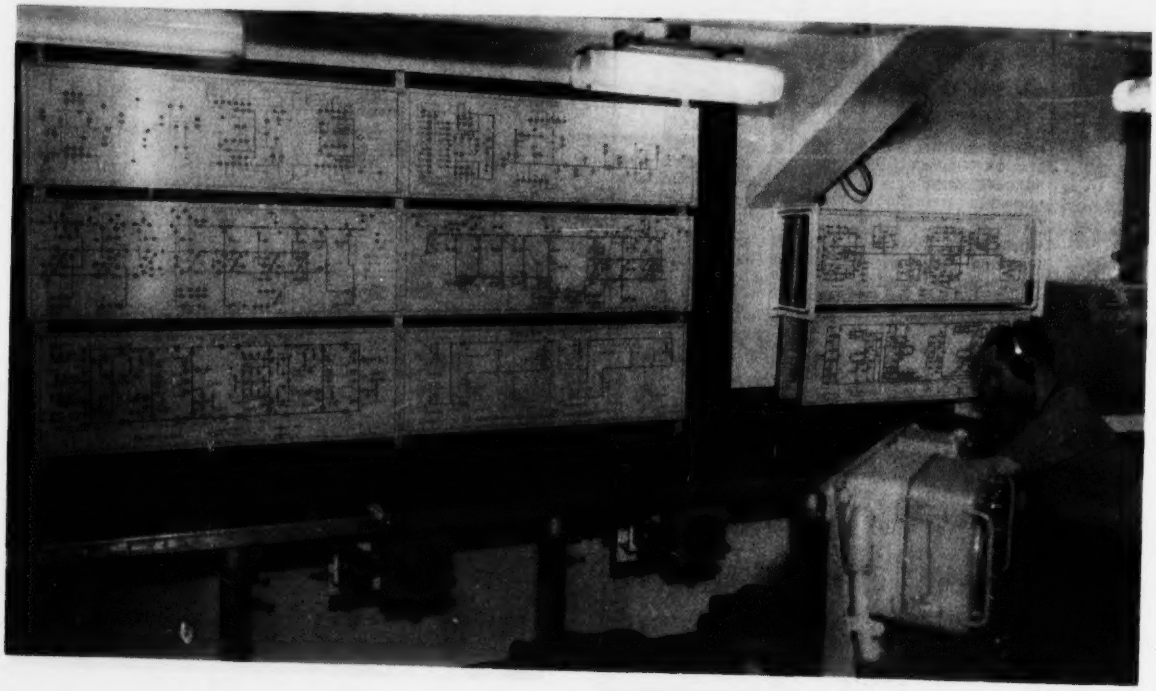
Plan views of the firemain system, the main steam system, and the main drain system are usually maintained on pegboards in DCC. The valves in these plan views are indicated by pegs that can be turned to show whether the valve is open or closed. A pegboard is shown in figure 2-7.

DAMAGE CONTROL COMMUNICATIONS

Damage control communications are vital to a ship's survival during emergency conditions. Each repair party is required to keep DCC informed of the damage status within its area. At the same time, each repair party needs to monitor the reports from all the other repair parties. By monitoring these reports, each repair party will be able to assume the duties of DCC if DCC becomes a battle casualty. If adequate DC communications are not maintained, the entire DC organization could break down rapidly and fail to perform its primary functions.

The following communication methods are used for DC communications:

1. Sound-powered battle telephone circuits
2. Interstation two-way intercoms
3. Ship's service telephones
4. Ship's loud speaker or general announcing system
5. Integrated voice communications system
6. Voice tubes
7. Messengers



8.76

Figure 2-7.—A pegboard.

As a Damage Controlman, you must be familiar with the communication systems used by the damage control organization on your own ship. Detailed information on communications can be found in the Ship Information Book for your ship. Various communication methods will be discussed in this chapter. However, the information given here must be regarded as general in nature; it does not apply to all types of ships.

BATTLE TELEPHONE CIRCUITS

The battle telephone circuits are sound-powered circuits. Therefore, they require no outside source of electrical power. The transmitter of a sound-powered telephone transforms sound waves into electrical energy. The receiver transforms this electrical energy back into corresponding sound waves.

Each sound-powered circuit provides communication between certain designated stations. Each circuit consists of telephone jack outlets connected by a line or lines. The connection may be direct or it may be through intermediate equipment such as switchboards, switch boxes, or transfer switches. Some of the vital circuits can be cross-connected with other circuits.

The sound-powered battle telephone system is made up of five types of circuits: primary, auxiliary, supplementary, emergency, and miscellaneous. Sound-powered telephones are also classified according to the type of control, as follows:

1. Switchboard-type circuits are controlled from a switchboard at a central location.
2. Switch box-type circuits are controlled from a switch box located at the station exercising operational control over the circuit.
3. String-type circuits have all stations connected in parallel, with no switching provided.

The primary, auxiliary, and supplementary circuits of the ship's battle telephone system are permanently installed. These circuits have outlets located at numerous critical locations throughout the ship. The emergency circuits are string-type circuits which have permanently installed jack boxes.

Primary Circuits

The number of primary circuits used within the sound-powered battle telephone system varies among ships. The choice of circuits is largely determined by the size and type of the ship. The primary circuits discussed here are normally found on large combatant ships. Not all of these circuits are found on smaller ships. The circuits discussed here include only those that are of particular importance in damage control communications.

CIRCUIT 2JZ is the damage and stability control circuit. This circuit provides vital communication between damage control central, secondary damage control central, engine rooms, repair stations, antiaircraft stations, weapons control center, and draft gauge. Each repair party circuit has an outlet in DCC. This may be through a selector switch, through individual jack boxes, or through a combination of both. The latter arrangement is preferred because it permits the manning of each circuit by individual phone talkers. When the combination of the selector switch and individual jack boxes is used, the 2JZ circuit is preferably used as an outgoing circuit. Information and orders from DCC are passed to the repair parties. Each individual repair party circuit thus becomes an incoming circuit into DCC. Therefore, the DCA either receives information or orders action to be taken on any message carried over any individual repair party circuit.

When individual repair party circuits come into DCC only through a selector switch, or when individual phone talkers are not available, the system must be reversed so that the 2JZ circuit becomes the incoming channel for information. The individual repair party circuits receive only such information or orders from DCC that are intended specifically for them.This may prevent repair party officers from receiving all of the information being sent to other repair parties.

In smaller ships, only a single circuit may be available. In this situation, both incoming and outgoing messages must be handled over it. It is also possible that this circuit will not be primarily or entirely a damage control circuit. Therefore, it is imperative that control of this circuit be established by the major controlling station. This will ensure an orderly flow of communication. The circuit must never be allowed to get out of control as a result of cross-talk when more than one station assumes priority. The controlling station must be able to clear the circuit immediately and establish priorities for messages whenever the need arises.

CIRCUIT 3JZ provides communication between Repair 1 and DCC, secondary DCC, topside battle dressing station and each unit patrol station associated with Repair 1.

CIRCUIT 4JZ provides communication between Repair 2 and DCC, secondary DCC forward battle dressing station, each unit patrol station forward of engineering compartments, fire pump controllers (except aircraft carriers), and fog-foam injection stations (aircraft carriers only).

CIRCUIT 5JZ provides communication between Repair 3 and DCC, secondary DCC, after battle dressing station, each unit patrol station associated with Repair 3, remote-operated valve control stations aft of the engineering compartments, fire pump controllers (except aircraft carriers), and fog-foam injection stations (aircraft carriers only).

CIRCUIT 6JZ provides communication between Repair 4 and DCC, secondary DCC, amidship battle dressing station, each unit patrol station associated with Repair 4, remote-operated valve control stations amidship, fire pump controllers (except on aircraft carriers), and fog-foam injection stations (aircraft carriers only).

CIRCUIT 7JZ provides communication between Repair 5 and DCC, secondary DCC, engine rooms, firerooms, and each unit patrol station associated with Repair 5.

CIRCUIT 8JZ provides communication between Repair 8 and DCC, secondary DCC, primary and secondary fly control, auxiliary fly control, and each unit patrol station associated with Repair 8.

CIRCUIT 9JZ provides communication between forward Repair 6-F and DCC, secondary DCC, gunnery control station, remote sprinkling control station and each manual sprinkling valve control unit.

CIRCUIT 10JZ provides communication between after Repair 6-F and DCC, secondary DCC, gunnery control station, remote sprinkling control stations and each manual sprinkling valve control unit.

CIRCUIT 12JZ provides communication for the operating orders for fire pump control and the maintenance of firemain pressure in the event of damage. Communication facilities are provided between such stations as DCC, secondary DCC, each conflagration station and hangar deck lighting control station, and the controllers for each fire pump.

CIRCUIT JA is the captain's battle circuit. This circuit provides communication between such stations as the open bridge, pilot house, captain plot, secondary conn, combat information center (CIC), gunnery control stations, antiaircraft stations, weapons control center, fire control plotting rooms, DCC, secondary DCC, and flag plotting station.

Auxiliary Circuits

Most ships have auxiliary circuits, which duplicate primary circuits. The wiring for the auxiliary circuits is installed as far away as possible from the wiring for the primary circuits. This helps to minimize the danger of both the primary and the auxiliary circuits being placed out of commission at the same time. The auxiliary sound-powered circuits are identified by an *X* in front of the circuit designator. Examples of auxiliary circuits are X2JZ and X1JV.

Supplementary Circuits

Supplementary circuits are primary circuits as related to their principal functions. However, when the circuit is also used for damage control communications, the circuit is considered as a supplementary circuit. The following primary circuits are examples of supplementary circuits when they are used for damage control purposes.

CIRCUIT 3JG provides communication between such stations as primary and secondary fly control, flight and hangar deck control stations, each aviation lubricating oil station on the hangar and the gallery deck walkway, flight deck crew shelters, and the lubricating oil pump controllers.

CIRCUIT 4JG provides communication for the supervision of the various elements of the high-capacity aviation gasoline and JP5 system. Communication facilities are provided between such stations as flight deck control station, DCC, secondary DCC, forward and after gasoline pump and control rooms (or gasoline control rooms), and aviation gasoline filling stations.

CIRCUIT 1JV is the maneuvering and docking circuit. This circuit provides communication between the pilot house, open bridge, secondary conn, DCC, engine rooms, emergency stations, steering gear rooms, k/gyro rooms, standard compass, fog watch forward and aft, secondary DCC, fog generator station, and each line-handling and transfer-at-sea station.

CIRCUIT 2JV is the engineering circuit for main engines. This circuit provides communication between DCC, each propulsion engine throttle station, auxiliary machinery room, refrigerating machinery room, air-conditioning machinery room, each shaft alley, and Repair 5.

CIRCUIT 3JV is the engineering circuit for boilers. This circuit provides communication between each boiler operating station, each main feed pump and feed booster pump, smoke watch, DCC, control engine room, auxiliary control engine room, and Repair 5.

CIRCUIT 4JV is the engineering circuit for fuel and stability. This circuit provides communication between DCC, the oil king, control engine room, secondary DCC, Repair 5, fuel oil transfer pumps, fuel oil manifolds, and sounding tubes.

CIRCUIT 5JV is an engineering circuit that provides communication between each ship's service power switchgear group, each load center switchboard, each emergency power switchboard, each IC/gyro room, each turret power transfer panel, DCC, secondary DCC, Repair 5, and steering gear room.

CIRCUIT JL is for surface and sky lookouts. The circuit is used primarily to pass reports from lookouts to the captain, gunnery officer, and CIC. Because of the location of the lookouts topside, they can help locate damage caused by high-angle shellfire and bombs.

Emergency Circuits

Emergency circuits are used to provide a means of re-establishing communications once a casualty has occurred to the primary lines. The emergency sound-powered circuit of main concern to damage control personnel is the X40J casualty control communication circuit. The X40J circuit provides portable emergency communications between the main below-deck stations after casualties have occurred to the primary circuits. Portable leads are used for communication between the outlets that are permanently connected to the below-deck stations forming this emergency circuitry. The below-deck stations are usually located in the firerooms, engine rooms, forward and aft IC rooms, emergency generator rooms, DCC, and steering gear rooms. These stations have individual single-gang jack boxes. These boxes are permanently installed and connected to individual four-gang jack boxes above decks. The four-gang outlets are wired in parallel but are not interconnected.

Repair party lockers are equipped with portable jack boxes and two-conductor twisted cable. These are commonly referred to as salt-and-pepper rigs. The salt-and-pepper rigs may be used to connect the individual X40J circuits to operating primary or auxiliary circuits or directly to the bridge.

Miscellaneous Circuits

There are several miscellaneous circuits that provide for the transmission of information of direct interest to damage control stations. The miscellaneous circuit that will affect you the most is the general announcing system circuit (1MC). The 1MC is used to put out information to the ship's crew on a regular basis each day. Some of the other miscellaneous circuits include the flooding alarm (FD), remote draft indicator (DG), and security alarm (FZ) circuits. Not all of the miscellaneous circuits transmit verbal messages. Some of the circuits are used for alarms that have a definite meaning. You will become acquainted with most of the miscellaneous circuits aboard ship while performing your daily duties.

INTERCOM UNITS

Intercom units (circuit 4MC) provide fast and dependable two-way communication between DCC and each repair party locker. One-way communication from each repair party locker to its unit patrol stations can be provided by using extra speakers at various places.

SHIP'S SERVICE TELEPHONES

Many ships use ship's service telephones for damage control communications when there are telephones installed at or near repair party lockers. The ship's service telephones are standard telephones. They are either rotary-dial or push button. The majority of the compartments aboard ship will have a telephone installed within them. However, do not depend too much on this system. It is not part of a rugged battle system, and it could easily be knocked out of commission early during battle action.

SHIP'S GENERAL ANNOUNCING SYSTEM

Another means of damage control communication is the ship's general announcing system (1MC circuit). Through use of the 1MC, information can be passed throughout the ship. This system should be used only to pass warnings or vital information that affects the entire ship's company. When information does not affect the entire ship, and other communication methods are available, the 1MC should not be used.

INTEGRATED VOICE COMMUNICATIONS SYSTEM

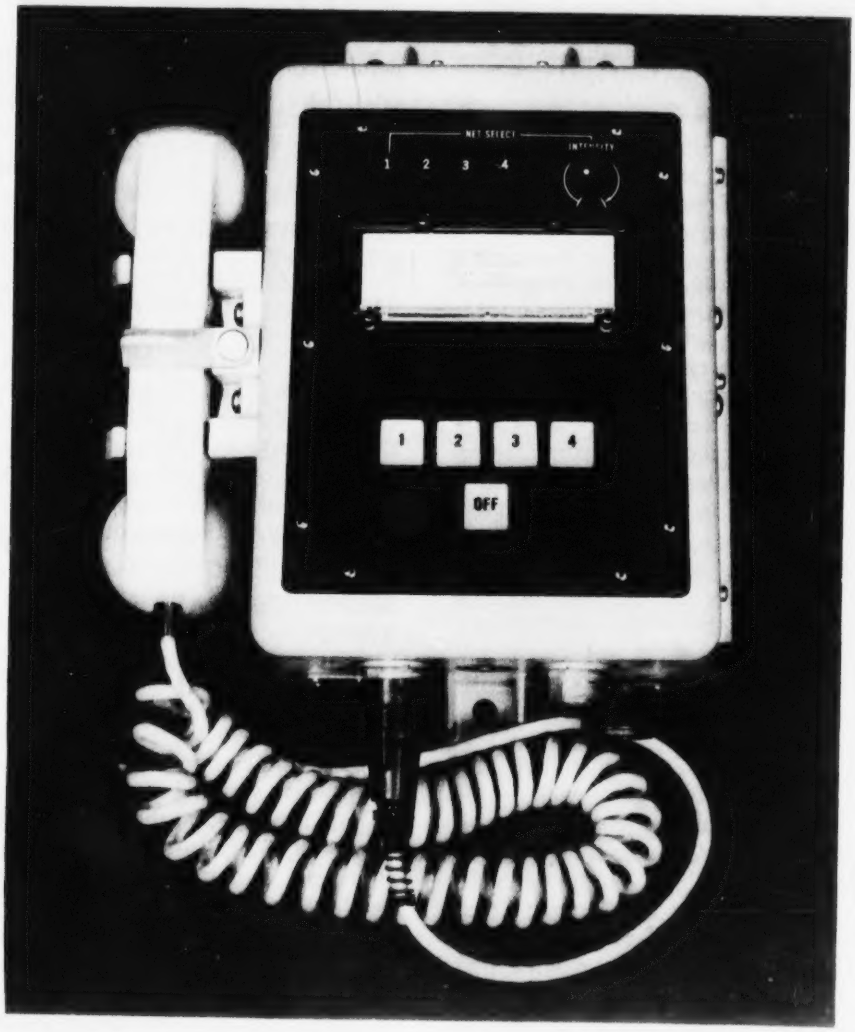
The integrated voice communications system (IVCS) is a computer-controlled telephone system.

It is a relatively new system within the Navy. The LHA-1 class ships were the first to receive the system. Now the CG-47 class ships are being fitted out with the IVCS. It is anticipated that future classes of ships will also be fitted with the IVCS.

The IVCS consolidates the communication functions and features normally provided by several systems into a single integrated network. A stored-program processor-controlled circuit-switching system provides for the interconnections. It consists of two interconnected interior-communications switching centers, dial terminals, net terminals, terminal accessories, and associated cabling. The IVCS allows for station-to-station telephone conversations, conference calls, and net communications. The IVCS also connects up with the ship's announcing system, shore telephone lines, radio communications, Man-on-the-Move (MOM) communications, and certain battle sound-powered telephone circuits. The two switching centers, one forward and one aft, contain the major control equipment for the system.

The hardware components will be quite similar from one class of ship to another. However, the system's capacity, number of terminals, and functional capabilities may be quite different among different classes of ships. The software programs should also be different. Frequent improvements to the system are expected to accommodate changes in the shipboard requirements.

IVCS nets are similar to the sound-powered telephone circuits. They are closed-loop communications circuits. All phone talkers on a net will be able to monitor the communication of any



8.452

Figure 2-8.—Call net terminal.

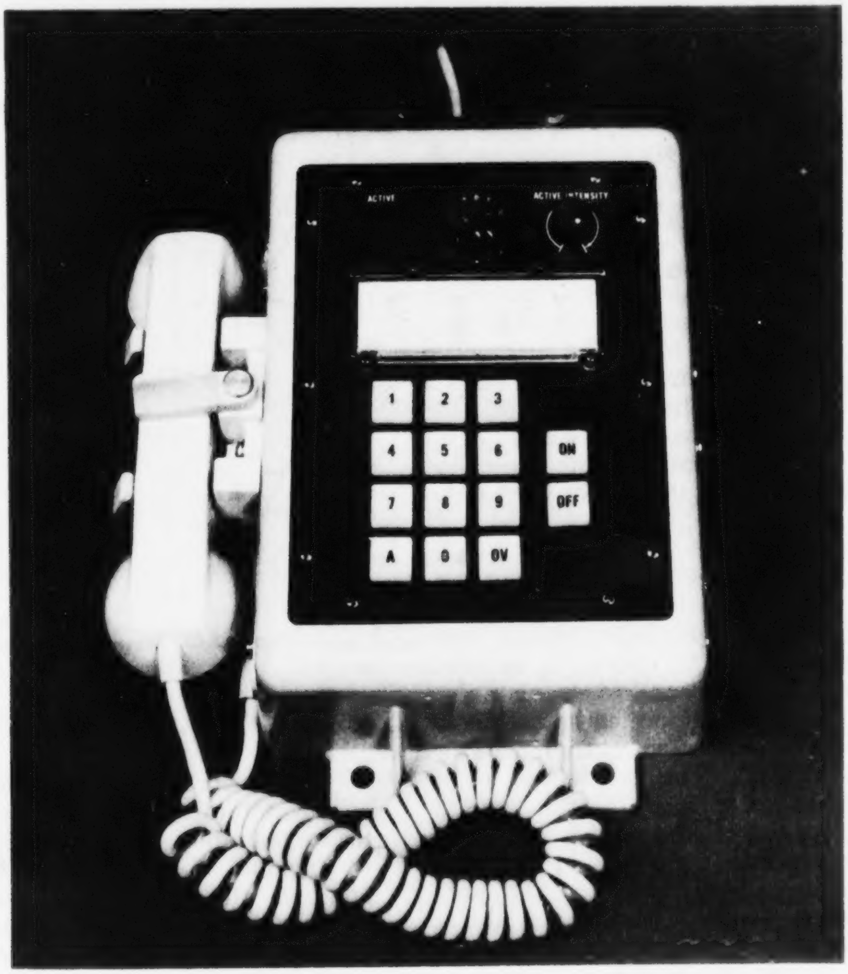
station on the net. Dial telephones, when given a permit by the computer program, may be used to dial into preselected nets. A permit is defined as a capability entered into the computer program for certain dial-phone terminals. Nets may be cross-connected at the switching center to allow two or more nets to be interconnected. Net numbers may vary between the various classes of ships. Just as in the sound-powered telephone system, net discipline must be maintained. If it is not, the net may become jammed and communications will break down.

The IVCS uses the following types of equipment to facilitate communications:

1. Net jack boxes—These replace the sound-powered telephone jack box and allow one phone talker to connect to one net. No call-out capability is provided. When a headset is connected and the jack box is turned on, the phone talker is in connection with all other phone talkers on the net.

2. Call net terminals—The call net terminals (fig. 2-8) have 4, 8, or 16 push buttons that allow for calling other call net terminals on the net. Either a headset or a handset may be connected to this terminal. No OFF-NET calls may be made from call net terminals. However, off-net calls may be made from a dial-telephone terminal if that terminal has the proper net permit.

3. Dial-telephone terminals—The dial-telephone terminals (fig. 2-9) replace the rotary-dial telephones. The terminals are push-button types and may use either a handset or a headset for communication. All dial-telephone terminals



8.453

Figure 2-9.—Dial-telephone terminal.

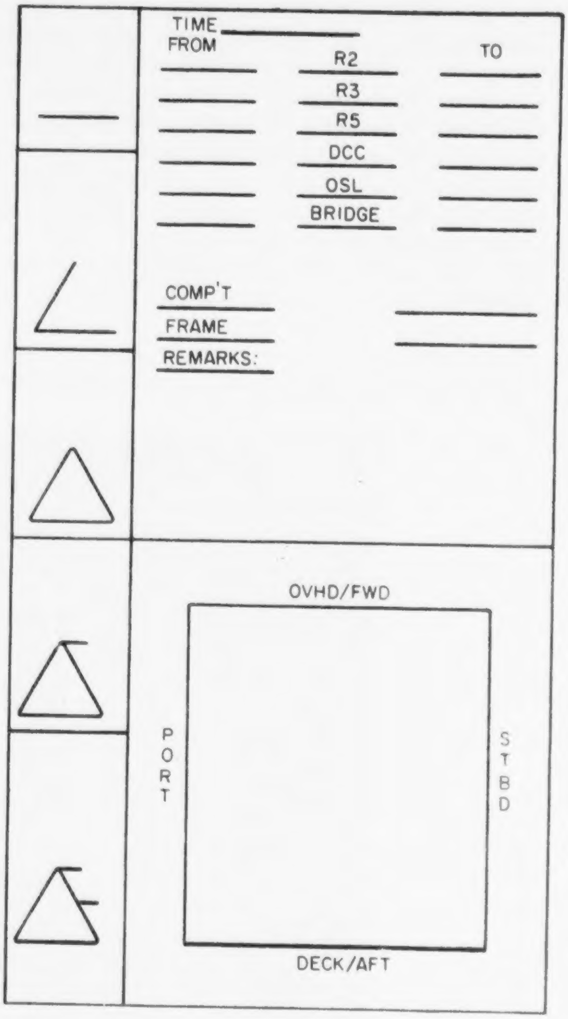
are capable of communicating with any other dial-telephone terminal on the ship. With the proper permit, they may be used to dial into nets, the ship's 1MC, the 5MC, selected radio circuits, or the interconsole intercoms in CIC. The interior-communication electricians are trained to alter the program to allow rapid changes to the IVCS permits. Permits may also be assigned to allow call forwarding, shore telephone access, call override, and conferencing. All dial-telephone terminals allow the answering party to transfer calls to another dial-telephone terminal.

4. Multi-line terminals—This terminal is similar to a telephone used in a business office. Up to five lines are connected to it, each with a separate telephone number. When you call a multi-line terminal and the first line is busy, the call will be automatically forwarded to the second number. A hold button allows the individual to put a call on hold to answer another line. These telephones are normally found only in very busy areas such as CIC, the bridge, and engineering control. Headsets, handsets, or speakers may be connected to these terminals.

5. Automatic terminals—These terminals are similar to the dial-telephones terminals, but these may be operated in the hands-free mode. The calling party controls the conversation with a push-to-talk button. When it is released, the calling party will hear the station called. When the button is depressed, the station called will be cut out so that the calling station can talk.

6. Headset—The IVCS headset may be connected to any terminal in the IVCS network. The IVCS uses a lightweight headset with no chest piece. The microphone is attached to a movable boom on one of the earpieces. A push-to-talk button is located on the phone cord; it must be depressed when the operator wishes to speak. This button has a clip to allow it to be attached to the wearer's clothing. The cord on the headset is a flexible coiled-type cord.

7. Handset—The IVCS handset may also be attached to any terminal in the IVCS network. It is similar to a regular telephone handset, except it has a push-to-talk button between the earpiece and the mouthpiece.



8.454

Figure 2-10.—Preprinted message blank.

MESSAGE BLANKS

A written message is another means of passing information within the damage control organization. To standardize this method of communication, preprinted message blanks are used (fig. 2-10). To write out a message word for word takes unnecessary time. Therefore, you should use the standard abbreviations for damage control fittings that are listed in figure 2-11. By using these abbreviations and the standard symbology shown

AD	ARMORED DOOR
AH	ARMORED HATCH
AQAES	ARMORED QUICK ACTING ESCAPE SCUTTLE
AP	AIR PORTS
ATC	AIR TEST CAP
BP	BATTLE PORTS
CP	CASUALTY POWER
CPPT	CASUALTY POWER PASSING TUBE
DDV	DECK DRAIN VALVE
DS	DECK SOCKET (REACH ROD)
DV	DRAIN VALVE
EVC	ELECTRICAL VENT CONTROLLER
EVM	ELECTRICAL VENT MOTOR
FFC	FIXED FOG CONNECTION
FWV	FRESH WATER VALVE
FWFV	FRESH WATER FILL VALVE
FLWV	FLUSHING WATER VALVE
FMCOV	FIRE MAIN CUTOUT VALVE
FMRV	FIRE MAIN RISER VALVE
FMV	FIRE MAIN VALVE
FOFT	FUEL OIL FILL TANK
FOFV	FUEL OIL FILL VALVE
FP	FIRE PLUG
FTD	FLAME TIGHT DOOR
GSV	GAGGED SCUPPER VALVE
HMHC	HINGED MAN HOLE COVER
HPAV	HIGH PRESSURE AIR VALVE
HRSCOV	HANDLING ROOM SPRINKLER CUTOUT VALVE
LPAV	LOW PRESSURE AIR VALVE
MHC	MAN HOLE COVER
MSCOV	MAGAZINE SPRINKLER CUTOUT VALVE
MPAV	MEDIUM PRESSURE AIR VALVE
NTD	NON TIGHT DOOR
OBDV	OVERBOARD DRAIN VALVE
PS	PASSING SCUTTLE
PVV	PLUMBING VENT VALVE
QAWTD	QUICK ACTING WATER TIGHT DOOR
QAES	QUICK ACTING ESCAPE SCUTTLE
QAWTH	QUICK ACTING WATER TIGHT HATCH
QAH	QUICK ACTING HATCH
RCV	REMOTE CONTROL VALVE
SPOD	SUBMERSIBLE PUMP OVERBOARD
SFT (W/W)(WO/W)	STUFFING TUBE (WITH WIRE) (WITHOUT WIRE)
STC	SOUNDING TUBE CAP
STWV	SOUNDING TUBE WITH VALVE
SWCOV	SALT WATER CUTOUT VALVE
SWE	SALT WATER TO EDUCTOR
VC	VENT COVER
VV	VENT VALVE
WTD	WATER TIGHT DOOR
WTH	WATER TIGHT HATCH
WTS	WATER TIGHT SCUTTLE
SLF	SECURITY LIGHT FIXTURE
CWV	CHILL WATER VALVE
CWCOV	PASSING TUBE WITH CAP
AFFFV	AQUEOUS FILM FORMING FOAM VALVE
AFFFCOV	AQUEOUS FILM FORMING FOAM CUTOUT VALVE
MCV	MANUAL CONTROL VALVE
AHD	AMMUNITION HOIST DOOR
AHC	AMMUNITION HOIST COVERS
AFFFFV	AQUEOUS FILM FORMING FOAM FILL VALVE

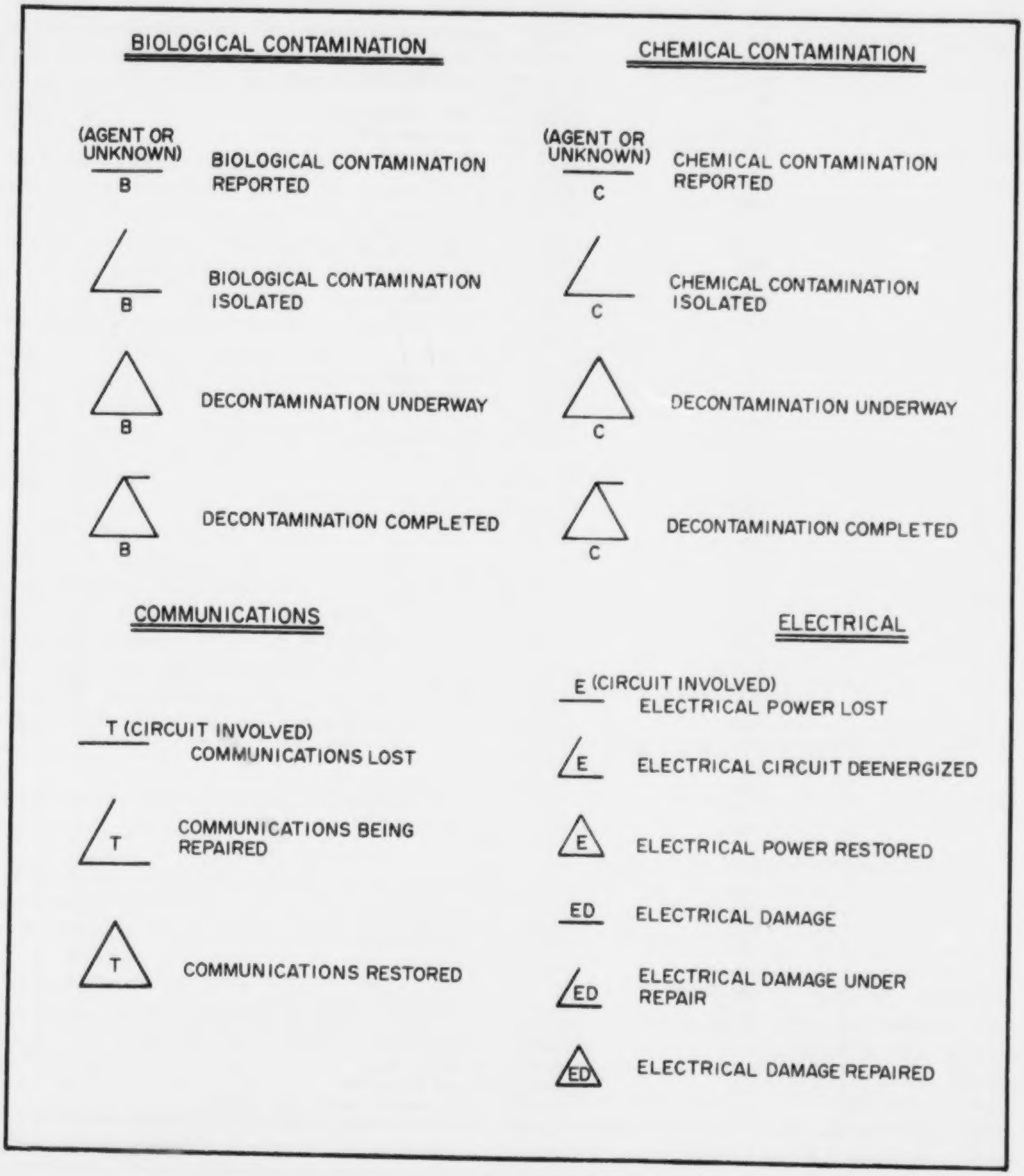
8.455

Figure 2-11.—Standard abbreviations for damage control fittings.

in figure 2-12, you can write a message in a minimum amount of time.

MESSENGER

The messenger's responsibility is to relay orders and information. These messages will normally be relayed between the scene, the repair locker, and, if in port, the quarter-deck. Written messages are always more reliable than oral messages. However, the messenger should be trained to relay oral messages without errors.



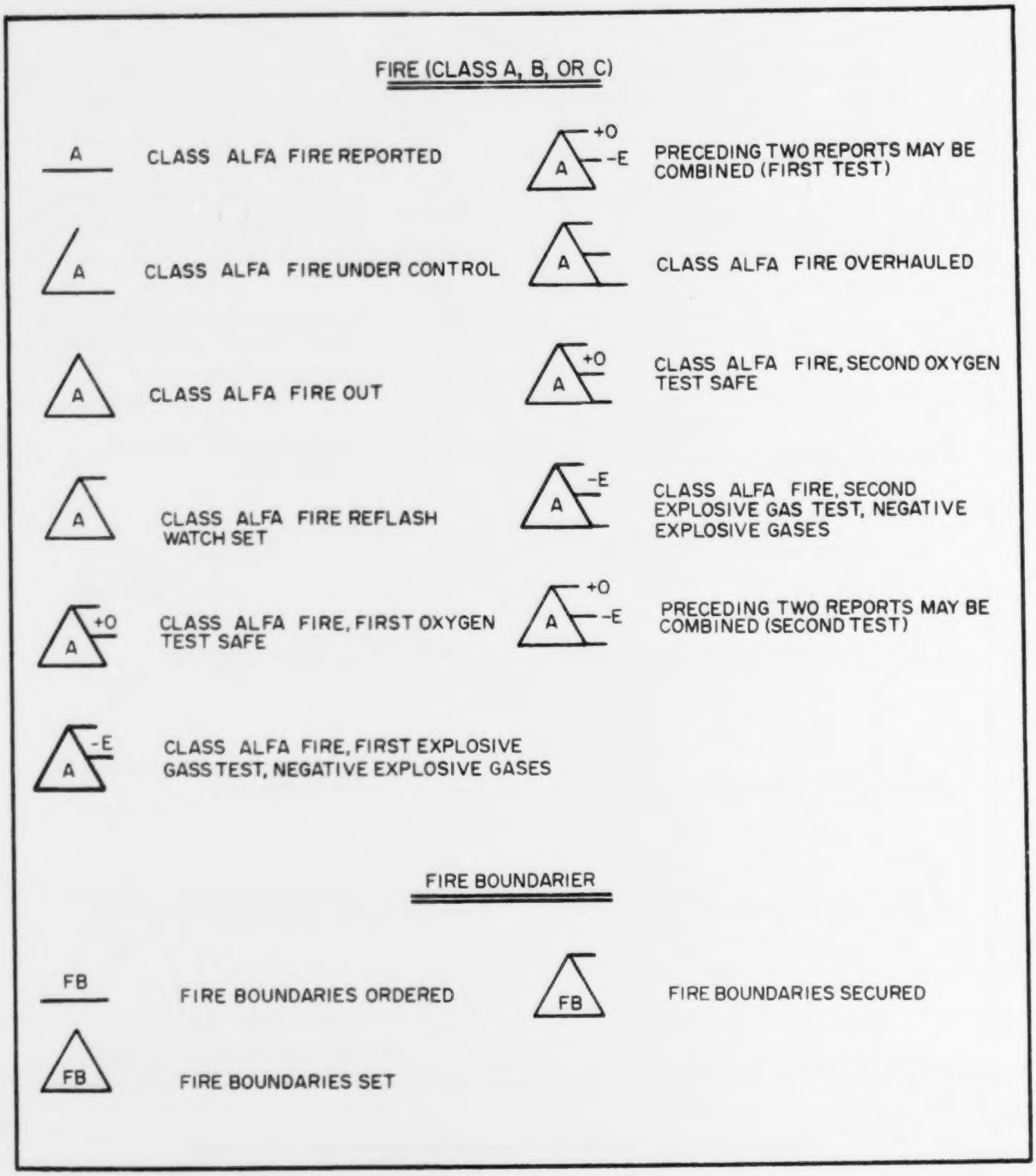
BIOLOGICAL CONTAMINATION
(AGENT OR UNKNOWN)
B
BIOLOGICAL CONTAMINATION REPORTED
B
BIOLOGICAL CONTAMINATION ISOLATED
B
DECONTAMINATION UNDERWAY
B
DECONTAMINATION COMPLETED
CHEMICAL CONTAMINATION
(AGENT OR UNKNOWN)
C
CHEMICAL CONTAMINATION REPORTED
C
CHEMICAL CONTAMINATION ISOLATED
C
DECONTAMINATION UNDERWAY
C
DECONTAMINATION COMPLETED
COMMUNICATIONS
T (CIRCUIT INVOLVED)
COMMUNICATIONS LOST
T
COMMUNICATIONS BEING REPAIRED
T
COMMUNICATIONS RESTORED
ELECTRICAL
E (CIRCUIT INVOLVED)
ELECTRICAL POWER LOST
E
ELECTRICAL CIRCUIT DEENERGIZED
E
ELECTRICAL POWER RESTORED
ED
ELECTRICAL DAMAGE
ED
ELECTRICAL DAMAGE UNDER REPAIR
ED
ELECTRICAL DAMAGE REPAIRED

8.456

Figure 2-12.—Navy standard damage control symbology.

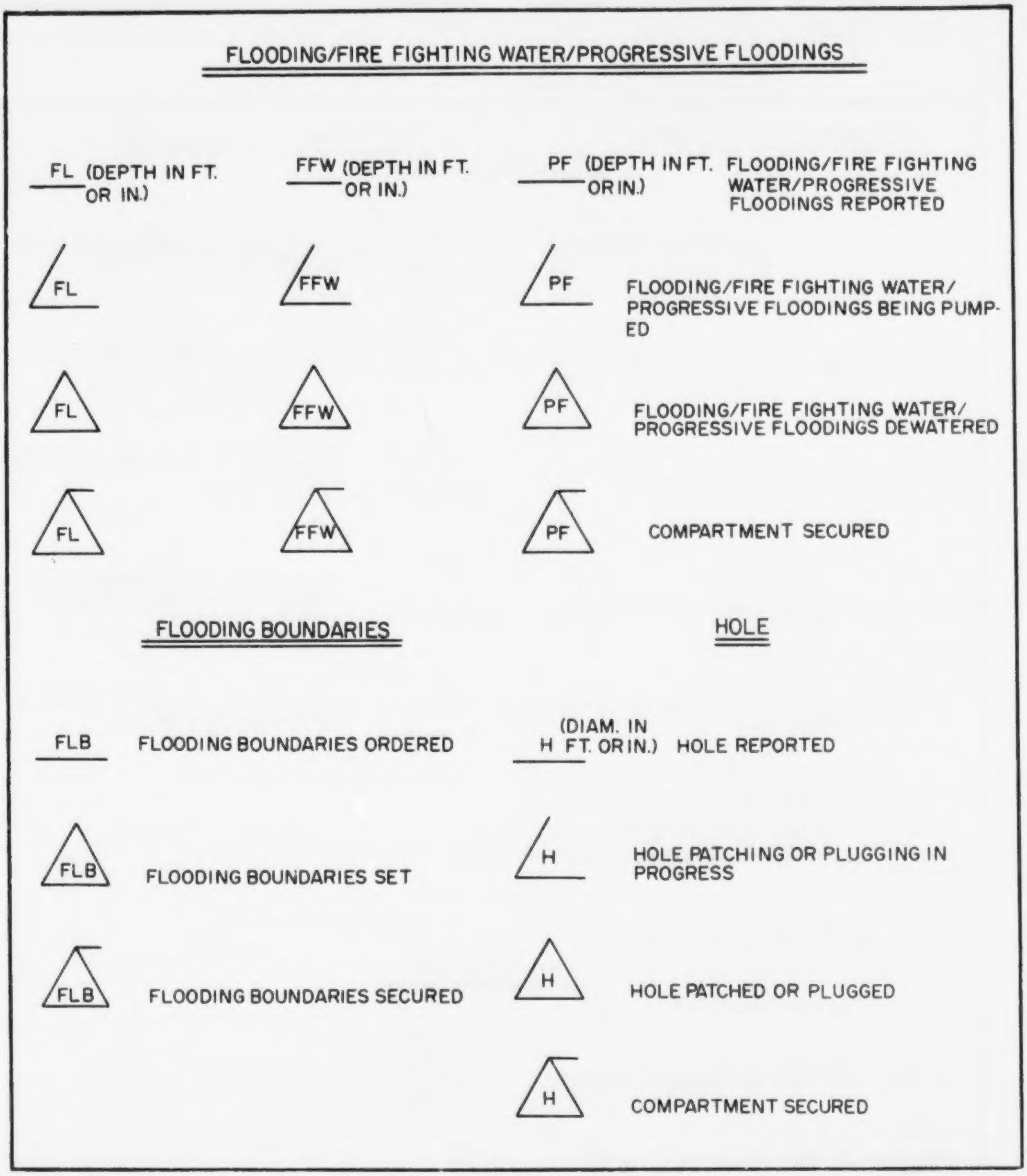
MAINTAINING COMMUNICATIONS

If you are a member of a repair party, you should understand and be able to use all of the available methods of communication. This includes the ability to switch from normal to alternative methods when necessary. Damage control communications drills should be held frequently; some circuits should actually be shorted without warning to test your ability to maintain communications during an emergency situation.


FIRE (CLASS A, B, OR C)
A
CLASS ALFA FIRE REPORTED
A
CLASS ALFA FIRE UNDER CONTROL
A
CLASS ALFA FIRE OUT
A
CLASS ALFA FIRE REFLASH WATCH SET
A +O
CLASS ALFA FIRE, FIRST OXYGEN TEST SAFE
A -E
CLASS ALFA FIRE, FIRST EXPLOSIVE GASS TEST, NEGATIVE EXPLOSIVE GASES
A +O -E
PRECEDING TWO REPORTS MAY BE COMBINED (FIRST TEST)
A
CLASS ALFA FIRE OVERHAULED
A +O
CLASS ALFA FIRE, SECOND OXYGEN TEST SAFE
A -E
CLASS ALFA FIRE, SECOND EXPLOSIVE GAS TEST, NEGATIVE EXPLOSIVE GASES
A +O -E
PRECEDING TWO REPORTS MAY BE COMBINED (SECOND TEST)
FIRE BOUNDARIER
FB
FIRE BOUNDARIES ORDERED
FB
FIRE BOUNDARIES SET
FB
FIRE BOUNDARIES SECURED

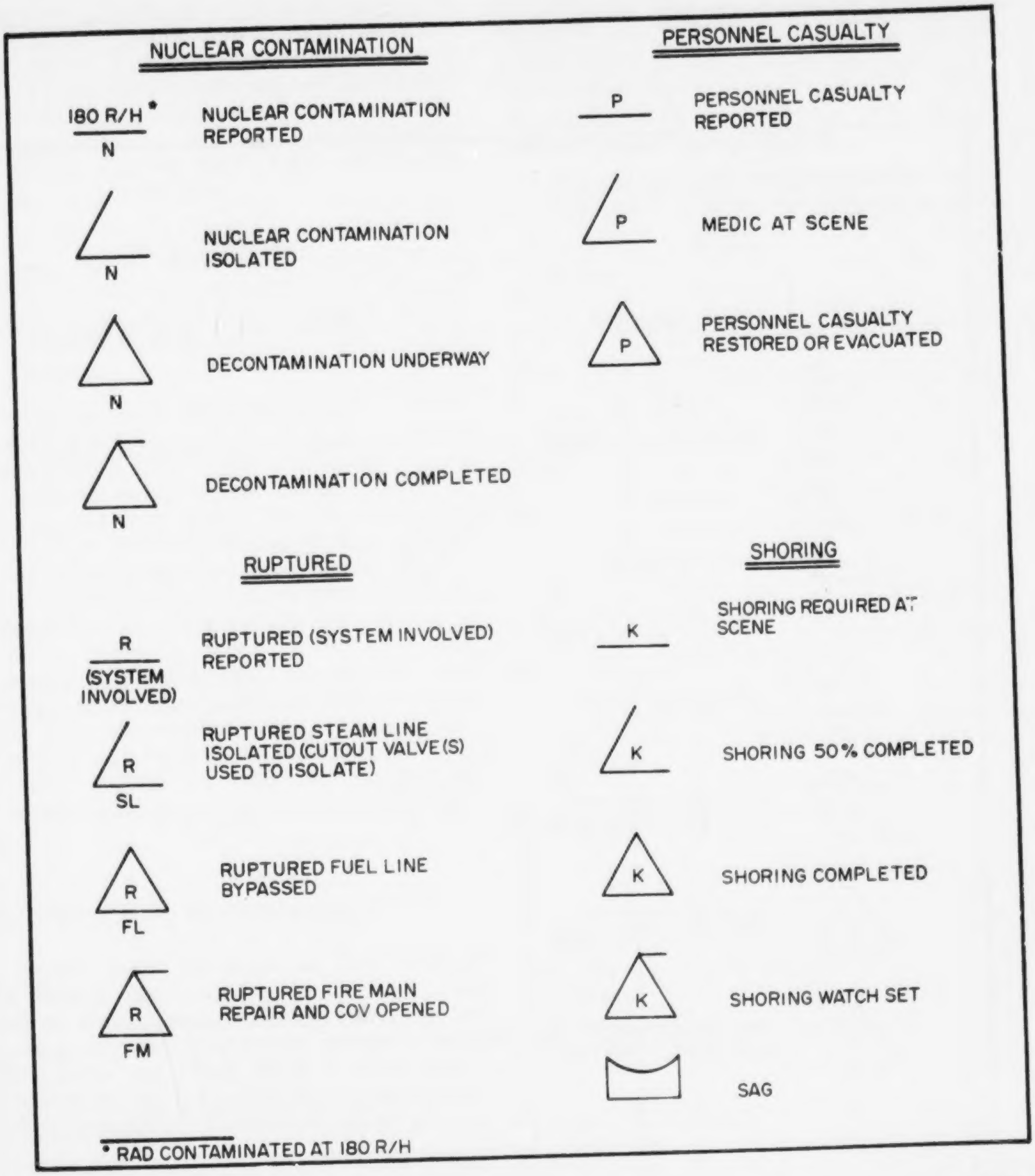
8.456.1

Figure 2-12.—Navy standard damage control symbology—Continued.


FLOODING/FIRE FIGHTING WATER/PROGRESSIVE FLOODINGS
FL (DEPTH IN FT. OR IN.)
FFW (DEPTH IN FT. OR IN.)
PF (DEPTH IN FT. OR IN.)
FLOODING/FIRE FIGHTING WATER/PROGRESSIVE FLOODINGS REPORTED
FL
FFW
PF
FLOODING/FIRE FIGHTING WATER/ PROGRESSIVE FLOODINGS BEING PUMPED
FL
FFW
PF
FLOODING/FIRE FIGHTING WATER/ PROGRESSIVE FLOODINGS DEWATERED
FL
FFW
PF
COMPARTMENT SECURED
FLOODING BOUNDARIES
HOLE
FLB
FLOODING BOUNDARIES ORDERED
H (DIAM. IN FT. OR IN.)
HOLE REPORTED
FLB
FLOODING BOUNDARIES SET
H
HOLE PATCHING OR PLUGGING IN PROGRESS
FLB
FLOODING BOUNDARIES SECURED
H
HOLE PATCHED OR PLUGGED
H
COMPARTMENT SECURED

8.456.2

Figure 2-12.—Navy standard damage control symbology—Continued.

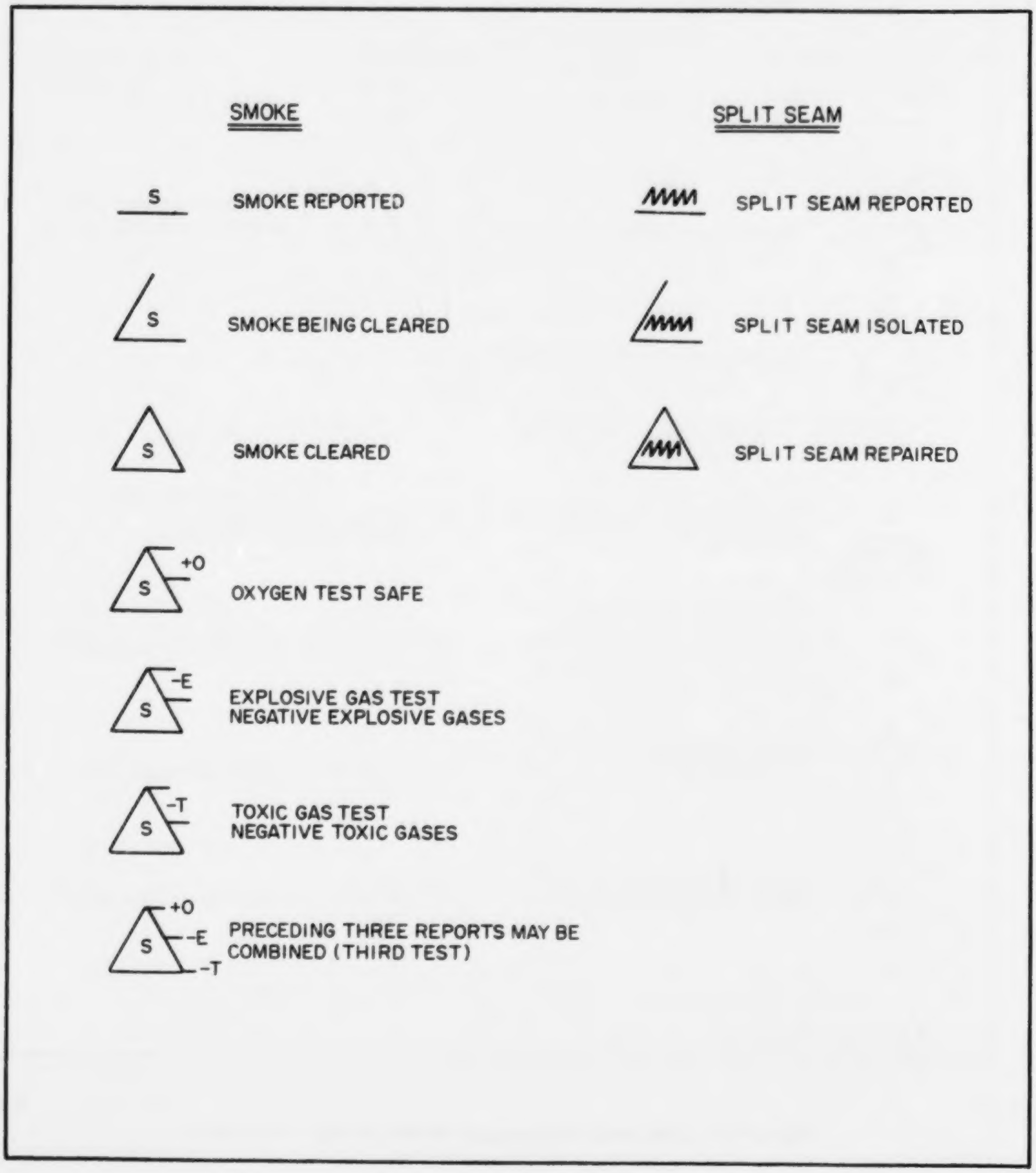

NUCLEAR CONTAMINATION
180 R/H*
N
NUCLEAR CONTAMINATION REPORTED
N
NUCLEAR CONTAMINATION ISOLATED
N
DECONTAMINATION UNDERWAY
N
DECONTAMINATION COMPLETED
PERSONNEL CASUALTY
P
PERSONNEL CASUALTY REPORTED
P
MEDIC AT SCENE
P
PERSONNEL CASUALTY RESTORED OR EVACUATED
RUPTURED
R
(SYSTEM INVOLVED)
RUPTURED (SYSTEM INVOLVED) REPORTED
R
SL
RUPTURED STEAM LINE ISOLATED (CUTOUT VALVE(S) USED TO ISOLATE)
R
FL
RUPTURED FUEL LINE BYPASSED
R
FM
RUPTURED FIRE MAIN REPAIR AND COV OPENED
SHORING
K
SHORING REQUIRED AT SCENE
K
SHORING 50% COMPLETED
K
SHORING COMPLETED
K
SHORING WATCH SET
SAG
* RAD CONTAMINATED AT 180 R/H

8.456.3

Figure 2-12.—Navy standard damage control symbology—Continued.

The succession of command for repair stations must be well established if you are to maintain communications control. The proper succession should be put into effect immediately if DCC is destroyed or otherwise put out of commission. The sequence of command for each ship is given in the ship's Repair Party Manual. Copies of the Repair Party Manual are located in DCC and each repair party locker.

Drills are useful in establishing the chain of succession. DCC may pretend to be out of


SMOKE
S
SMOKE REPORTED
S
SMOKE BEING CLEARED
S
SMOKE CLEARED
S
+O
OXYGEN TEST SAFE
S
-E
EXPLOSIVE GAS TEST
NEGATIVE EXPLOSIVE GASES
S
-T
TOXIC GAS TEST
NEGATIVE TOXIC GASES
S
+O
-E
-T
PRECEDING THREE REPORTS MAY BE
COMBINED (THIRD TEST)
SPLIT SEAM
SPLIT SEAM REPORTED
SPLIT SEAM ISOLATED
SPLIT SEAM REPAIRED

8.456.4

Figure 2-12.—Navy standard damage control symbology—Continued.

commission by not answering up. This will provide a test of the organization and the procedures of the repair party station designated to assume command. The repair party taking control should notify all other repair parties, the commanding officer, and main engine control that it has control. This procedure should be followed until all repair parties have succeeded to control and have exercised their control properly. DCC can always regain control by saying "Damage control central taking control," and receiving the proper acknowledgments.

This drill should emphasize the necessity for all repair parties to maintain a record of all information and orders issued by DCC. When a repair party succeeds to damage control central, it must know what casualties the other stations are handling.

Communication difficulties become apparent when there are numerous hits or other casualties throughout the ship. Under these conditions, all repair parties usually try to send information to DCC at the same time. The communication circuits can become overloaded and jammed unless proper control is maintained. A priority system for different types of messages should be established. The priority of messages should be understood by all repair party personnel. Messages containing vital information, and messages that require immediate action by some other damage control unit should be sent first. Then other important messages or reports should be sent. Routine or relatively unimportant messages should not be transmitted until the lines are free.

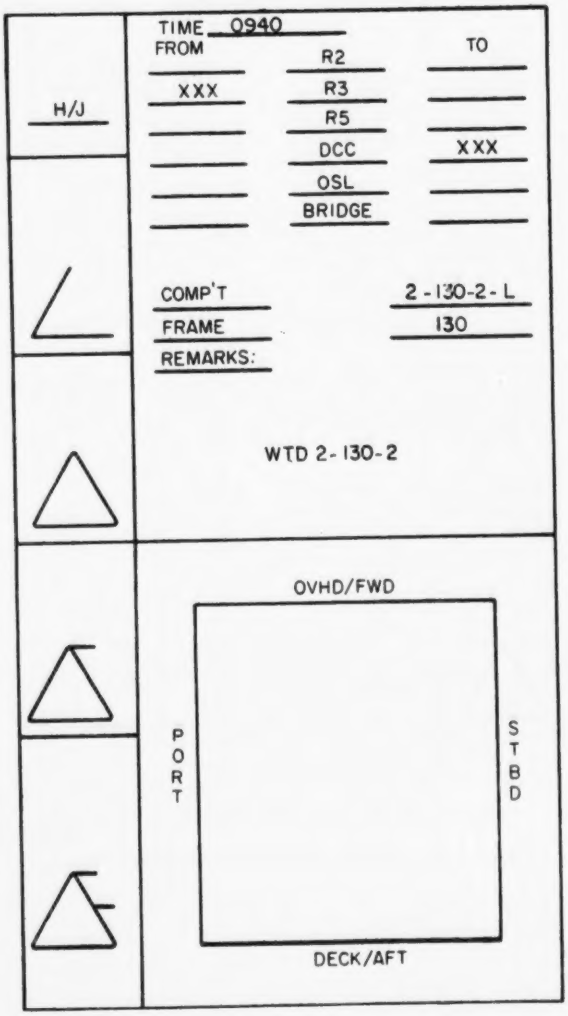
TRANSMITTING INFORMATION

Repair party personnel at the scene of the damage are obviously in the best position to provide accurate information on the casualty. However, the entire damage control organization can break down if repair party personnel do not know how to transmit information correctly.

The initial report from a repair party should contain the location and the nature of the damage. Subsequent reports should contain information on the extent of the damage, the measures being taken to correct the damage, and assistance required (if any). These general guidelines for transmitting information from repair parties to DCC apply to both oral reports and written messages.

As an example, consider the following series of reports. These reports concern an exercise for a fire in a living compartment resulting from a bomb or shell hit. The ship is at general quarters. These reports are set up as message blank reports. However, the same information would be required if you were making oral reports over a damage control communication circuit.

The first message blank report (fig. 2-13) is from Repair 3 to DCC. The message is written


H/J

TIME 0940

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L
FRAME 130
REMARKS:

WTD 2-130-2

OVHD/FWD
PORT
STBD
DECK/AFT

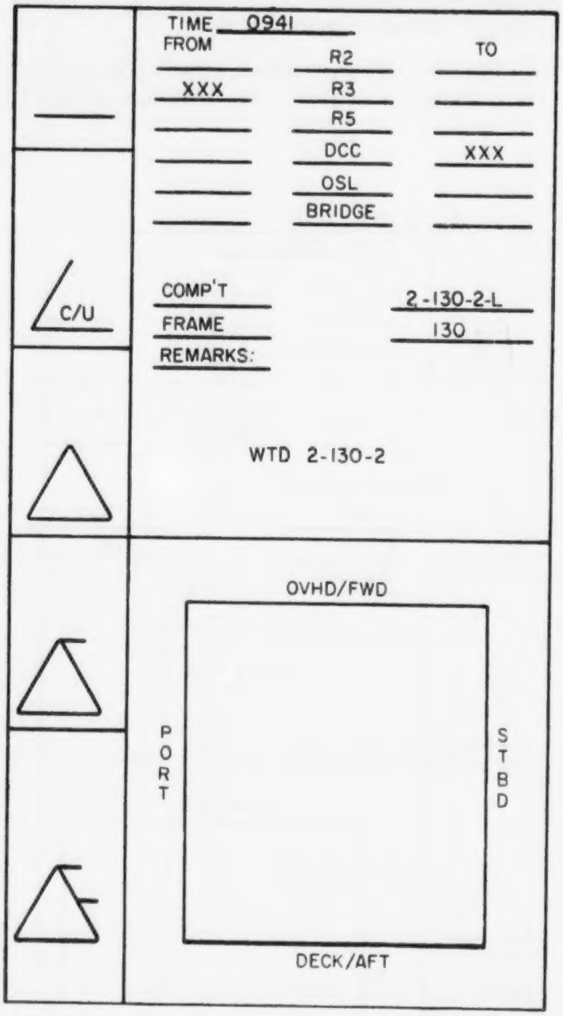
8.457

Figure 2-13.—Sample message of the first report.

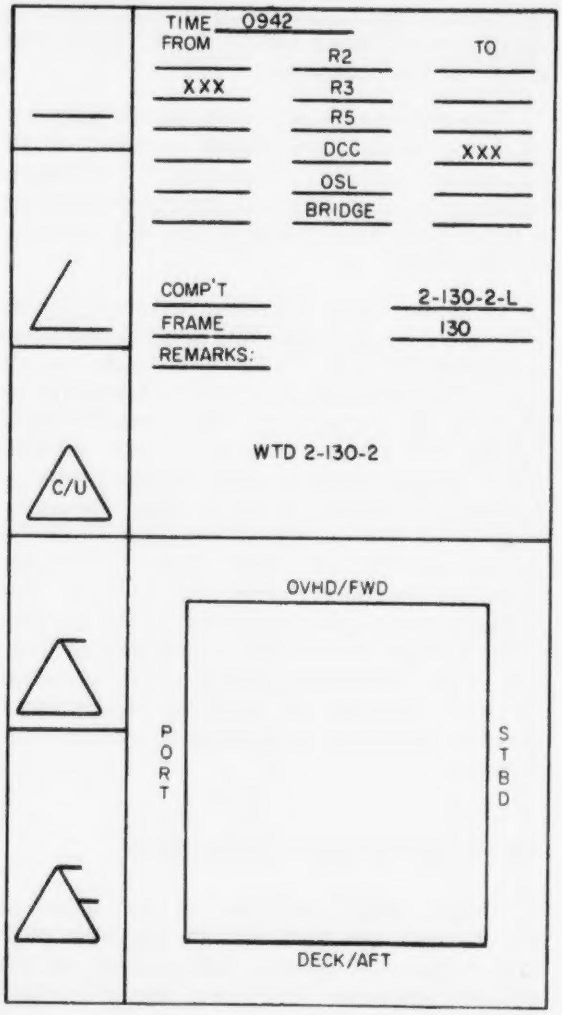
WTD 2-130-2 H/J. This means that watertight door 2-130-2 is hot and jammed (H/J).

The second report from Repair 3 to DCC is C/U IN PROGRESS (fig. 2-14). This means that corrective action is being taken to cool and unjam the watertight door so it can be opened.

The third report from Repair 3 to DCC is WTD 2-130-2 C/U (cooled and unjammed) (fig. 2-15).


TIME 0941
FROM XXX R3
TO XXX DCC
COMP'T 2-130-2-L
FRAME 130
REMARKS:
WTD 2-130-2
C/U
R2
R5
OSL
BRIDGE
OVHD/FWD
PORT
STBD
DECK/AFT

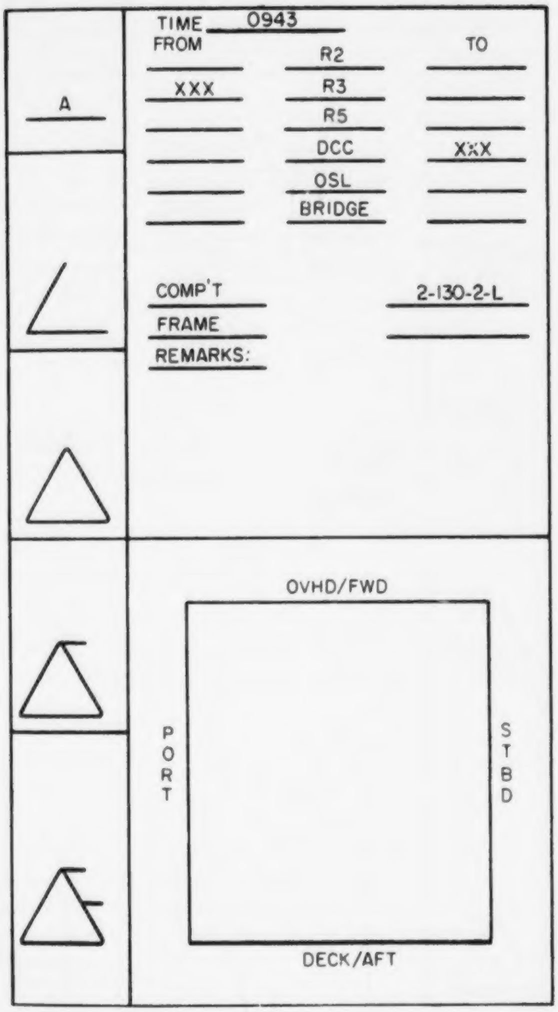
8.458
Figure 2-14.—Sample message of the second report.


TIME 0942
FROM XXX R3
TO XXX DCC
COMP'T 2-130-2-L
FRAME 130
REMARKS:
WTD 2-130-2
C/U
R2
R5
OSL
BRIDGE
OVHD/FWD
PORT
STBD
DECK/AFT

8.459
Figure 2-15.—Sample message of the third report.

The fourth report from Repair 3 to DCC is CLASS ALFA FIRE, COMPARTMENT 2-130-2-L (fig. 2-16).

The fifth report from Repair 3 to DCC is CLASS ALFA FIRE UNDER CONTROL, COMPARTMENT 2-130-2-L (fig. 2-17).



TIME 0943

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L

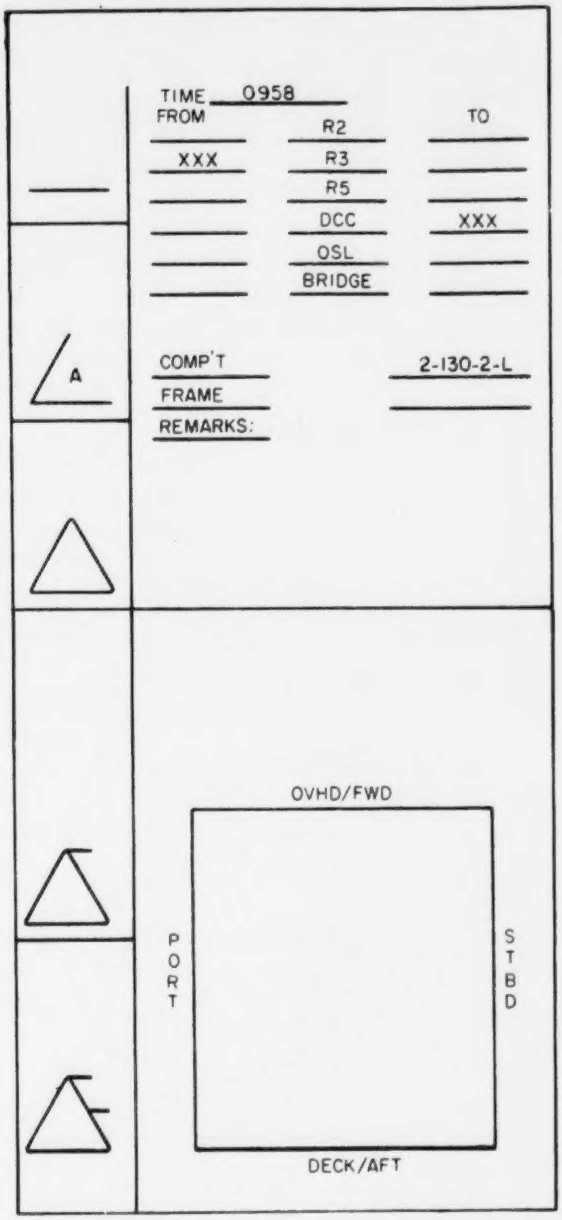
FRAME

REMARKS:

A
OVHD/FWD
PORT
STBD
DECK/AFT

8.460

Figure 2-16.—Sample message of the fourth report.



TIME 0958

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L

FRAME

REMARKS:

A
OVHD/FWD
PORT
STBD
DECK/AFT

8.461

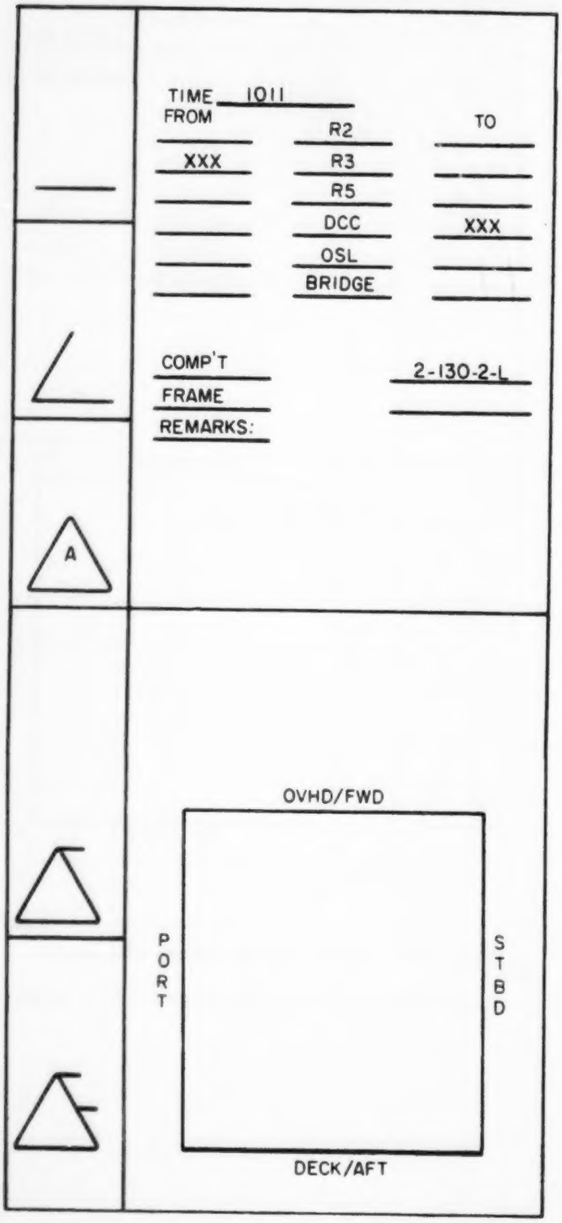
Figure 2-17.—Sample message of the fifth report.

The sixth report from Repair 3 to DCC is CLASS ALFA FIRE OUT, COMPARTMENT 2-130-2-L, (fig. 2-18).

The seventh report from Repair 3 to DCC is REFLASH WATCH SET BY FN JONES, COMPARTMENT 2-130-2-L, (fig. 2-19).

The eighth report from Repair 3 to DCC is First compartment atmospheric test shows sufficient oxygen and no explosive gases present in COMPARTMENT 2-130-2-L (fig. 2-20). OBAs are required to be worn in the compartment until after the third atmospheric test. There must be sufficient oxygen and no explosive or toxic gases present before you may remove your OBA.

Additional reports would be required for the additional atmospheric tests, personnel casualties, electrical damage, investigation of the surrounding areas, desmoking, dewatering, ruptured firemains, holes in the hull, shoring, and overhauling the compartment. In all reports, be



TIME 1011

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L

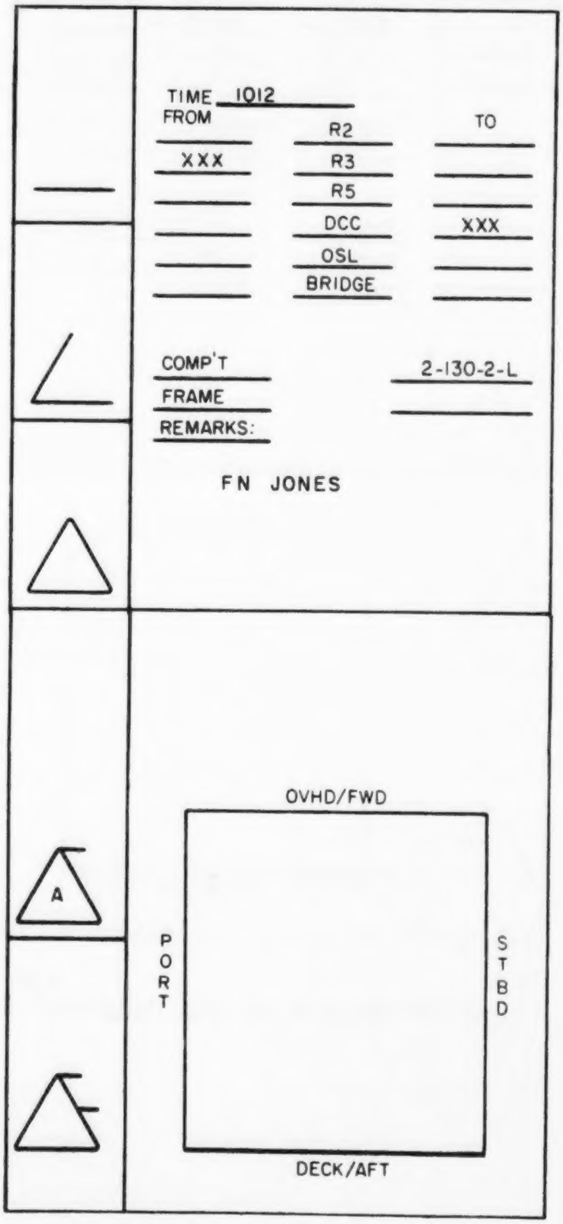
FRAME

REMARKS:

A
OVHD/FWD
PORT
STBD
DECK/AFT

8.462

Figure 2-18.—Sample message of the sixth report.



TIME 1012

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L

FRAME

REMARKS:

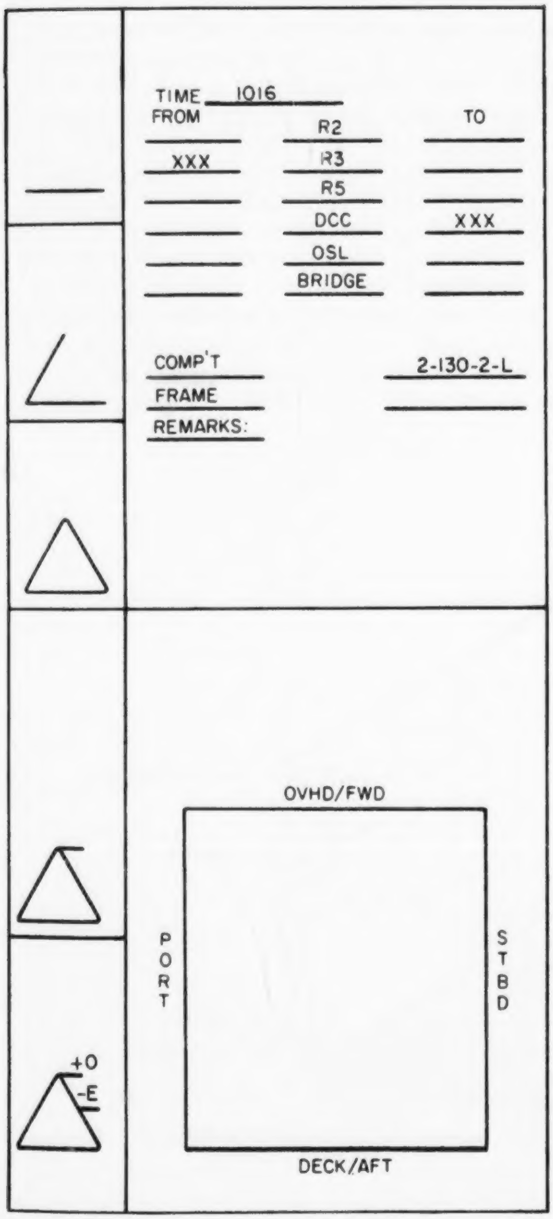
FN JONES

A
OVHD/FWD
PORT
STBD
DECK/AFT

8.463

Figure 2-19.—Sample message of the seventh report.

sure to pinpoint the damage as closely as possible. This will help to give DCC a clear picture of the damage. For example, do not just say, HOLE IN COMPARTMENT 2-107-1-L. Instead, say, COMPARTMENT 2-107-1-L, FRAME 112, 8-INCH HOLE, STARBOARD SIDE, 4 FEET OFF DECK. (See fig. 2-21.) A specific message of this type gives DCC an exact picture of the damage.



TIME 1016

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

COMP'T 2-130-2-L

FRAME

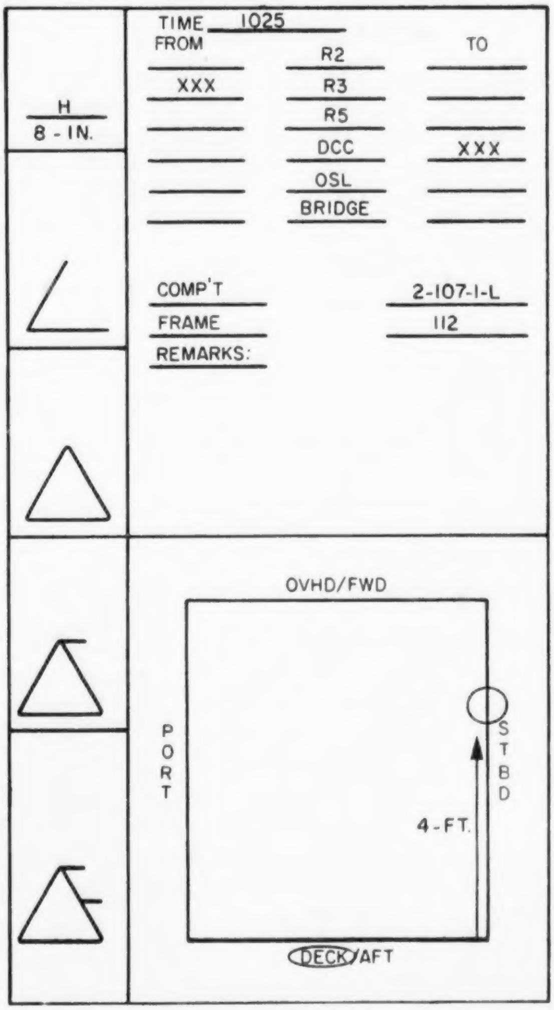
REMARKS:

8.464

Figure 2-20.—Sample message of the eighth report.

SUMMARY

This chapter has covered the organization of the damage control program aboard ship and some sources of information that cover damage control. You learned about the functions of the various repair parties and the personnel within those parties. You studied the use of blueprints and diagrams in damage control. Also, you have learned about various communications systems aboard ship and how they work in damage control. Take a moment now for a mental review of this chapter. If you feel unsure about some area, go back and review it before you move on to the next chapter.



TIME 1025

FROM		TO
	R2	
XXX	R3	
	R5	
	DCC	XXX
	OSL	
	BRIDGE	

H
8 - IN.

COMP'T 2-107-1-L

FRAME 112

REMARKS:

8.465

Figure 2-21.—Sample message to report the size and location of a hole.

CHAPTER 3

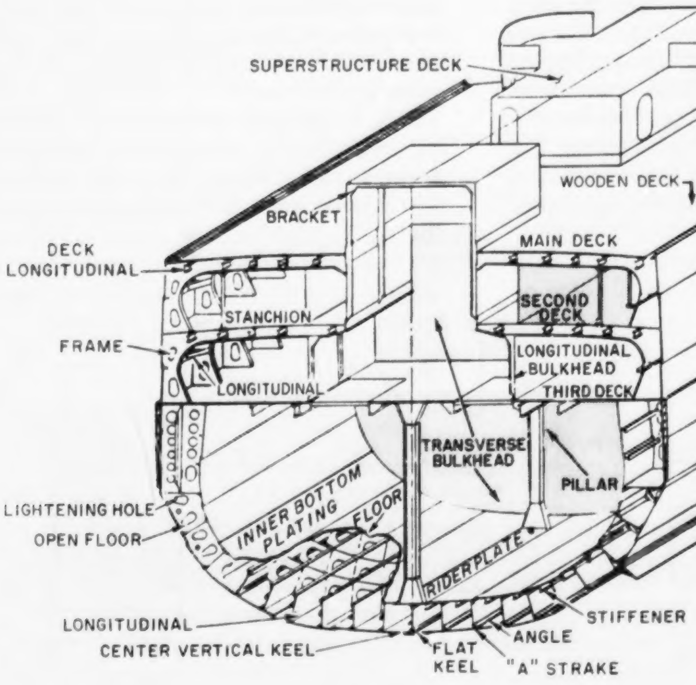
SHIP COMPARTMENTATION AND WATERTIGHT INTEGRITY

A ship's ability to resist sinking after sustaining damage depends largely on the ship's compartmentation and watertight integrity. When these features are maintained properly, fires and flooding can be isolated within a limited area. Without compartmentation or watertight integrity, a ship faces almost certain doom if it is severely damaged and the emergency damage control (DC) teams are not properly trained or equipped.

In this chapter, you will be introduced to compartmentation, material conditions of readiness, watertight integrity, and how they relate to each other. You will also learn about compartment checkoff lists, the DC closure log, the proper care of access closures and fittings, compartment inspections, the ship's draft, and the sounding and security patrol watch. You will need to know the information in this chapter to complete your PQS for general damage control.

COMPARTMENTATION

The compartmentation of a ship is a major feature in its watertight integrity. Compartmentation divides the interior area of the ship's hull into smaller spaces by the use of structural members. Refer to figure 3-1 while reviewing the following information on structural members.


SUPERSTRUCTURE DECK
GUNWALE
WOODEN DECK
SHEER STRAKE
"H"
BRACKET
SHELL PLATING
"G"
DECK LONGITUDINAL
MAIN DECK
SECOND DECK
STANCHION
FRAME
"F"
ARMOR BELT
LONGITUDINAL BULKHEAD
LONGITUDINAL
THIRD DECK
"E"
"D"
TRANSVERSE BULKHEAD
PILLAR
BILGE KEEL
LIGHTENING HOLE
INNER BOTTOM PLATING
FLOOR
OPEN FLOOR
RIDER PLATE
STIFFENER
LONGITUDINAL
ANGLE
CENTER VERTICAL KEEL
FLAT KEEL
"A" STRAKE

3.92

Figure 3-1.—Hull structure of a cruiser.

The keel is the backbone of the ship. On steel ships the keel does not extend below the ship's bottom. Its usual shape is that of an I-beam. All other members used in constructing the hull are attached, either directly or indirectly, to the keel.

The athwartship structure consists of transverse frames and floors. The floors run outboard from the keel to the turn of the bilge (where the bottom turns upward). This is where they are attached to the transverse frames that extend upward to the main deck.

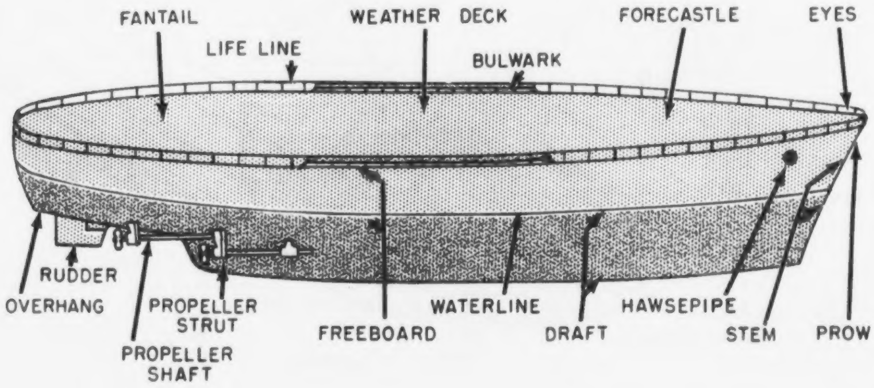
Frames running parallel with the keel are known as longitudinal frames. From the turn of the bilge up the sides they are called stringers. The network of floors and longitudinals resembles a honeycomb and is known as cellular construction, which greatly strengthens the bottom. When the honeycomb is covered by plating, double bottoms are formed. The space between the inner and outer bottoms (known as tanks) is used for liquid stowage. Planks laid upon the tank tops are called ceilings. The forward end of the keel is extended upward in the stem. The after end has a similar extension called the sternpost. The part of the stem above water is the prow; the forward edge of the stem is the cutwater.

The interior of a ship is divided into compartments by vertical walls, called bulkheads, which run both transversely and longitudinally. Most bulkheads are merely partitions, but transverse watertight bulkheads are spaced at appropriate intervals. These structural bulkheads extend from the keel to the main deck and from side to side. They provide extra transverse stiffening, and partition the hull into independent watertight sections. Largeships have a series of longitudinal side bulkheads and tanks that provide protection against torpedoes. The outer tanks usually are filled with oil or water. The inner tanks, which are called voids, are empty. The innermost bulkhead is called a holding bulkhead. When a torpedo hits, the outer tanks, although ruptured, absorb enough energy from the explosion that the holding bulkhead will remain intact. This helps to prevent flooding of the vital spaces.

The hull plating is fastened to the framework in longitudinal rows called strakes. The keel forms the center strake. The strakes are lettered, beginning with the A-strake on either side of the keel, and extending up to the main deck. Some of the strakes also have names. The A-strake is called the garboard strake; the strake along the turn of the bilge is the bilge strake; the uppermost strake is the sheer strake. A projecting keel running along the bottom near the turn of the bilge is called a bilge keel. Its purpose is to reduce rolling of the ship. (A ship rolls from side to side; it pitches when it goes up and down fore and aft; it yaws when the bow swings to port and starboard because of wave action.)

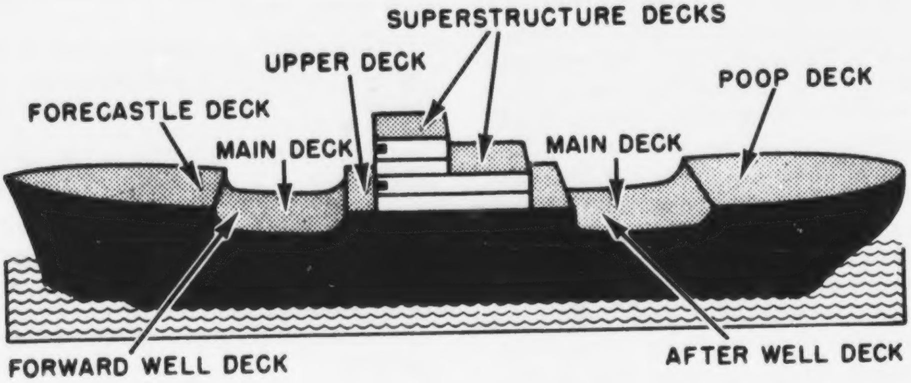
The upper edges of the sides where the sheer strakes join the main deck are called the gunwales (rhymes with funnels). The foremost part of the ship, where the gunwales join the stem, is known as the eyes of the ship. Where the gunwales curve inward to the sternpost are the port and starboard quarters.

The water level along the hull of a ship afloat is the waterline. The vertical distance from the keel to the waterline is the ship's draft. Freeboard is the distance from the waterline to the main deck.



3.94

Figure 3-2.—Hull terms.


SUPERSTRUCTURE DECKS
UPPER DECK
POOP DECK
FORECASTLE DECK
MAIN DECK
MAIN DECK
FORWARD WELL DECK
AFTER WELL DECK

3.95

Figure 3-3.—Weather decks.

Figures 3-2 and 3-3 illustrate some hull and deck terms.

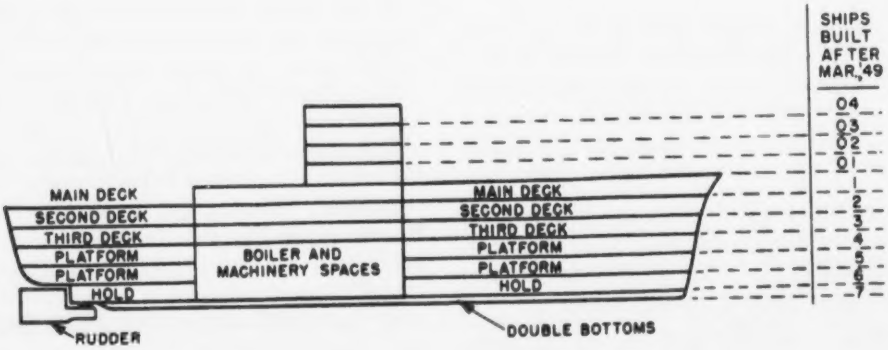
The floors of a ship are called decks. They divide the ship into layers and provide additional hull strength and protection for internal spaces. The lower surface of each deck forms the overhead (never the ceiling) of the compartment below. Compartments are the spaces within a ship.

A steel deck is made of strakes running fore and aft. The outboard strake in the deck plating is composed of stringer plates, which are welded or riveted to the side plates and are, therefore, important strength members. Decks are supported by transverse frames (deck beams) and by longitudinals (deck girders). Further deck support is provided throughout the ship by vertical steel pillars called stanchions. These are mounted one above the other or one above a strength bulkhead. (The short posts used as lifeline supports also are called stanchions.) Decks usually are arched from the gunwale to the centerline to provide for drainage of water and to strengthen the deck.

A deck or part of a deck exposed to the weather is called a weather deck (fig. 3-3). Bulwarks are a sort of solid fence along the gunwale of the main (weather) deck. It is fitted with freeing ports (scuppers) to allow the water to run off during heavy weather.

A deck that extends from side to side and stem to stern is a complete deck. In aircraft carriers the uppermost complete deck is the flight deck, from which aircraft take off and land. In all ships (except for aircraft carriers) the uppermost complete deck is the main deck. In aircraft carriers the hangar deck is the main deck. The hangar deck is the deck on which aircraft are stowed and serviced when not on the flight deck.

The first complete deck below the main deck is the second deck (fig. 3-4), the next the third, the next the fourth, and so on.


SHIPS BUILT AFTER MAR. '49
04
03
02
01
1
2
3
4
5
6
7
MAIN DECK
SECOND DECK
THIRD DECK
PLATFORM
PLATFORM
HOLD
BOILER AND MACHINERY SPACES
MAIN DECK
SECOND DECK
THIRD DECK
PLATFORM
PLATFORM
HOLD
RUDDER
DOUBLE BOTTOMS

3.106

Figure 3-4.—Deck numbering system.

A strength deck is a complete deck (usually the main deck) designed to carry not only deck loads on it but also the hull stresses. The damage control deck is the lowest deck having access through the main transverse bulkheads, from forward to aft. The main repair equipment and the principal facilities for the control of flooding, sprinkling, and pumping under conditions of damage are located on this damage control deck. The DC deck is either the second or third deck on most ships.

Following are definitions of the decks in modern ships. The location of each deck is also given.

Forecastle deck (pronounced fohk'sel): The deck is above the main deck at the bow. Ships that do not have raised forecastles are called flush-deckers. In them the part of the main deck from the stem to just abaft the anchor windlass is the forecastle.

Half deck: Any partial deck between complete decks.

Platforms: Partial decks below the lowest complete deck. They are usually broken to admit machinery or other spaces and are called platform decks or just platforms. They are numbered downward, as first platform, second platform, and so on.

Flats: Plating or gratings installed only to provide working or walking surfaces above bilges.

Levels: Level is a general term used to designate deck heights above the main deck. The first level above the main deck is the 01 (pronounced oh-one) level, the second the 02 level, and so on. Different decks at a particular level, however, carry different names. For example, both a poop deck and a boat deck (usually) are on the 01 level.

Upper deck: A partial deck extending from side to side above the main deck amidships. It is part of the superstructure, which is the part of a ship's structure above the main deck, exclusive of masts, yards, stacks, and related parts. The side plating extends upward to the upper deck.

Superstructure deck: A partial deck above the main, upper, or forecastle deck that does not extend to the sides of the ship; or if it does, it does not have the side plating carried up to it.

Poop deck: A partial deck above the main deck located all the way aft. A flush decker does not have a poop deck, so the stern area of the main deck on a flushdecker is called the main deck aft or the fantail.

Well deck: (Forward) part of the main deck between upper deck and forecastle, and (after) between the upper deck and the poop deck.

Gallery deck: First deck or platform below the flight deck.

Quarterdeck: The quarterdeck is not an actual deck, but an area designated by the commanding officer for the conduct of official functions. It is the station of the officer of the deck in port, and usually is on the main deck at the starboard gangway.

Companionways (ladders) lead from one deck level to another; they may or may not be covered by hatches.

The number of compartments into which these decks and bulkheads subdivide the ship's interior area will depend upon how many the ship's mission will allow. These compartments are both above and below the waterline. When the degree of compartmentation on a ship is increased, that ship's resistance to sinking is also increased. Compartmentation serves the following functions.

- Allows for more effective control of fires and floods.
- Strengthens the ship's structure.
- Helps defend against a chemical, biological, and radiological (CBR) attack.
- Segregates various ongoing activities.
- Provides underwater protection by the use of tanks and voids to help control the ship's buoyancy and stability.

Most large combatant ships have an armor belt to protect the vital machinery spaces. Armor plating may reduce the ship's speed or have an adverse effect on the operation of the ship. Aircraft carriers are a prime example where excessive armor plating would interfere with the ship's operation by reducing the ship's speed. Therefore, armor plating on aircraft carriers is reduced, while compartmentation is increased to compensate for the reduction of armor.

COMPARTMENT NUMBERING

Every compartment in a ship (except minor spaces, such as peacoat lockers, linen lockers, and cleaning gear lockers) is assigned a compartment number. This number is marked on a label plate that is secured to the door or hatch, and on a 12-inch by 15-inch yellow rectangle on the bulkhead. The Navy uses two systems to number compartments: one is for ships built before March 1949, and the other for ships built after March 1949. Both of these systems agree in the following respects:

- All compartments on the port side end in an even number.
- All compartments on the starboard side end in an odd number.
- A zero precedes the deck number for all levels above the main deck; for example, 01, 02, and 03.

Figure 3-4 shows both of the systems used to number decks. The older system uses 100, 200, 300, and so forth, and always 900 for the double bottoms. The new system uses 1, 2, 3, and so forth, and the double bottoms are given whatever number befalls them.

SHIPS BUILT BEFORE MARCH 1949

An example of a compartment number on ships built before March 1949 follows. Use this example when reading the following explanation:

C-203-A

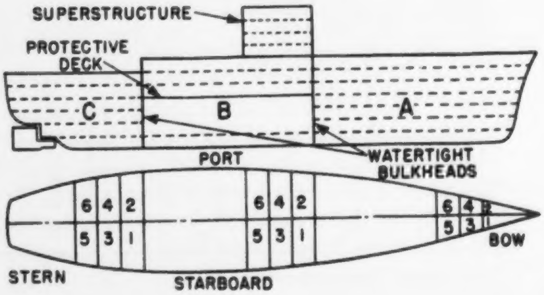
After part of ship
Second deck
Compartment number (starboard side)
Compartment usage (storeroom)

On ships built before March 1949, the first letter of the compartment number is A, B, or C. This letter indicates the section of the ship in which the compartment is located. The A section extends from the bow of the ship aft to the forward transverse bulkhead of the propulsion machinery spaces. The B section comprises all of the spaces between the forward transverse bulkhead of the forward propulsion machinery compartment and the after transverse bulkhead of the after propulsion machinery compartment. The C section extends from the after transverse bulkhead of the propulsion machinery spaces aft to the stern. The three sections of the ship are shown in figure 3-5. The lower half of the diagram shows how compartments are numbered, beginning at the forward end of each section. The even numbers are on the port side, and the odd numbers are on the starboard side.

Following the section letter is a three- or four-digit number indicating the deck and compartment number. The first number represents the deck number, the next two the compartment. Main deck compartments are indicated by numbers 102, 109, 117, and so forth. Second deck compartments run from 201 through 299. Third deck compartments are numbered in the 300 series. A zero preceding the first number represents a location above the main deck. The double bottoms always form the 900 series on a ship built before March 1949, regardless of the number of decks above the double bottom.

The third part of the compartment number is a letter that designates the contents or primary use of the compartment. The primary purpose of a compartment is indicated by the following letters:

A—Storerooms
B—Battery compartments (gunnery)
C—Ship control and fire control
E—Machinery compartments
F—Fuel compartments
LUB—Lubricating oil storage tanks
GAS—Gasoline compartments
L—Living compartments and passageways
M—Ammunition spaces
T—Trunks
V—Void compartments
W—Water compartments



3.107

Figure 3-5.—Pre-1949 divisions of a ship.

SHIPS BUILT AFTER MARCH 1949

The following example is for ships built after March 1949. Use this example when reading the following explanation.

2-175-7-A

Second deck

Frame number

Fourth compartment to starboard from the centerline

Compartment usage (stowage)

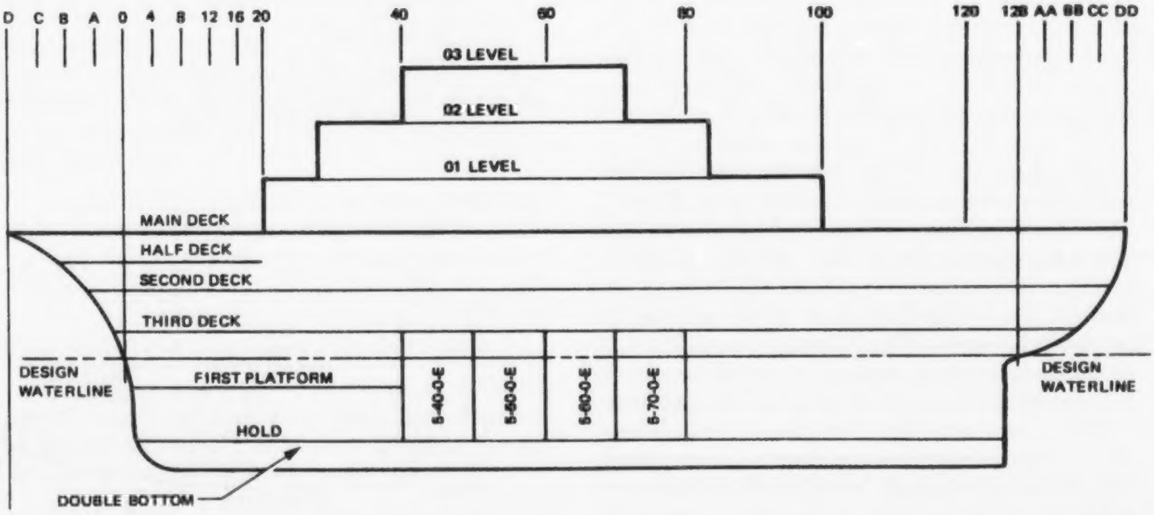
On ships built after March 1949, the compartment number consists of a deck number, a frame number, a number indicating the relationship of the compartment to the ship's centerline, and a letter showing the primary use of the space. Where a compartment extends through two or more decks, the number of the lower deck is used. The frame number indicates the location of the foremost boundary of the compartment. Frames are identified according to their location to the forward perpendicular and aft perpendicular. The forward perpendicular on a ship (fig. 3-6) is formed by drawing an imaginary line straight up from the forward-most point of the designer waterline (DWL). The after perpendicular is formed in the same manner, but from the aft-most point of the DWL.

All frames forward of the forward perpendicular are identified by a capital letter, starting with A. These frames are identified by starting with the first frame forward of the forward perpendicular and working forward.

The frames aft of the aft perpendicular are identified with double capital letters, starting with AA. These frames are identified by starting with the first frame aft of the aft perpendicular and working aft.

The frames between the forward perpendicular and the aft perpendicular are identified by numbers. The forward perpendicular is identified by the number 0 (zero). Each frame aft of the forward perpendicular will carry the next higher consecutive number. The last numbered frame is the aft perpendicular. If the forward boundary of a compartment is located between frames, the frame number farthest forward within the compartment is used.

Compartments located on the ship's centerline carry the number 0. Compartments completely to starboard are given odd numbers, and those to port are given even numbers. Where two or more compartments have the same deck and frame number, they have consecutively higher odd or even numbers, as applicable, numbering from the centerline outboard. In this instance, the first



8.466

Figure 3-6.—Frame numbering.

compartment to starboard is 1, the second is 3, and so on. To port of the centerline they are numbered 2, 4, and so forth. When the centerline passes through more than one compartment, each of which has the same frame number, the compartment having the forward bulkhead through which the centerline passes carries the number 0; the others are numbered 01, 02, 03, as applicable (fig. 3-7).

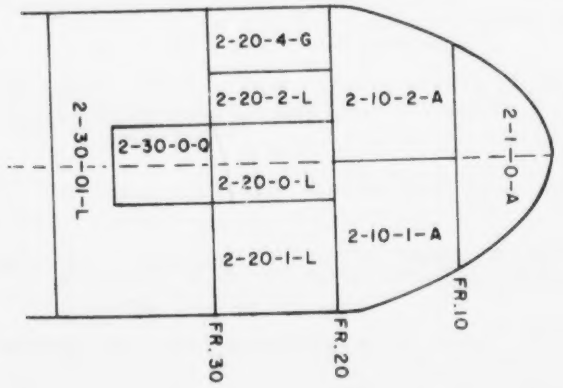
The last part of the compartment number is the letter that identifies the primary usage of the compartment. On dry- and liquid-cargo ships, a double letter is used to designate cargo spaces. The double letter will differentiate them from spaces containing the same commodity for use by the ship. Fuel oil and JP-5 jet fuel are two examples.

Compartment usage in the post-1949 system is shown in table 3-1.

Access closures are numbered in the same manner as compartments, except that the letter designating the compartment's use is omitted (example: 2-175-3).

WATERTIGHT INTEGRITY

The watertight integrity of a naval ship is established when the ship is built. This original watertight integrity may be reduced or destroyed through enemy action, storm damage, collision, stranding, or negligence. The damage control officer (engineer officer) is responsible for ensuring that the ship's watertight integrity is not impaired through negligence. Any impairment that occurs must be corrected as soon as possible. The ship's material condition of readiness in effect will also increase or decrease the ship's level of watertight integrity.



3.286

Figure 3-7.—Post-1949 compartment designations.

MATERIAL CONDITION OF READINESS

The term *material condition of readiness* refers to the degree of access and system closure in effect at any given time. The securing of access fittings or systems limits the extent of damage that could occur to a ship. To keep from interfering with the normal operation of the ship, maximum closure is not maintained at all times. For damage control purposes, naval ships have three material conditions of readiness. Each condition represents a different degree of tightness and protection. The three material conditions of readiness are called XRAY, YOKE, AND ZEBRA. These titles have no connection with the phonetic alphabet. Furthermore, the titles are used in all spoken and written communications that concern material conditions.

Condition XRAY provides the least amount of protection. It is set when the ship is in no danger of attack. Examples are when the ship is at anchor in a well-protected harbor or when secured at a home base during regular working hours.

Condition YOKE provides more protection than condition XRAY. It is set and maintained at sea during peacetime, and in port during wartime. It is also maintained in port during peacetime outside of regular working hours.

Condition zebra is set prior to leaving or entering port during wartime. It is also set immediately, without further orders, when manning general quarters stations. Also, condition ZEBRA is set to isolate and control fires and flooding when the ship is not at general quarters stations.

All watertight, airtight, firetight, and fumetight access fittings will be classified. Each classification applies to a certian group of fittings. Although the fittings are usually classified by a basic classification, a select group of closures within each of the three material conditions of readiness will be modified. The purpose of the modified closures is to allow access to a space that is secured because of the material condition that is set. Once a material condition is set, no fitting within the condition is to be opened, except as noted. Closures that are not modified require permission of the commanding officer to be opened. Permission to open a closure is obtained

Table 3-1.—Compartment Letters for Ships Built after March 1949

Letter	Type of compartment	Examples
A	Stowage spaces	Store and issue rooms; refrigerated compartments.
AA	Cargo holds	Cargo holds and cargo refrigerated compartments.
C	Control centers for ship and fire control operations (normally manned).	CIC; plotting rooms; communication centers; pilot-house; electronic equipment operating spaces; IC rooms.
E	Engineering control centers (normally manned).	Main machinery spaces; evaporator rooms; steering gear rooms; pumprooms; auxiliary machinery spaces; emergency generator rooms.
F	Oil stowage compartments (for use by ship).	Fuel-, diesel-, and lubricating-oil compartments.
FF	Oil stowage compartments (cargo)	Compartments carrying various types of oil as cargo
G	Gasoline stowage compartments (ship use)	Gasoline tanks, cofferdams, trunks, and pumprooms
GG	Gasoline stowage compartments (cargo)	Spaces for carrying gasoline as cargo
J	JP-5 fuel (ship use)	Jet fuel stowage spaces
JJ	JP-5 fuel (cargo)	Spaces for carrying JP-5 fuel as cargo
K	Chemicals and dangerous materials (other than oil and gasoline)	Chemicals, semisafe materials, and dangerous materials carried as cargo or for ship's use
L	Living spaces	Berthing and messing spaces; staterooms; washrooms; heads; brig; sickbay; and passageways
M	Ammunition spaces	Magazines; handling rooms; turrets; gun mounts; shell rooms; ready service rooms
Q	Miscellaneous spaces not covered by other letters	Laundry; galley; pantries; wiring trunks; unmanned engineering; electrical and electronic spaces; shops; offices
T	Vertical access trunks	Escape trunks
V	Voids	Cofferdam spaces (other than gasoline); void wing compartments
W	Water stowage spaces	Drainage tanks; freshwater tanks; peak tanks; reserve feedwater tanks

147.26

through the damage control central (DCC) watch or the officer of the deck (OOD) when the ship is not manning the general quarters stations. Repair party officers control the opening and closing of all fittings in their assigned areas when the ship is at general quarters. Any change in the status of a fitting must be reported to DCC so that the ship's DC closure log may be updated. You may open a modified closure without any special authorization. However, you are not authorized to leave the closure open unattended. Through careful attention to these procedures, a ship's watertight integrity can be maintained at a safe level.

The following discussion will help you learn about each classification, how the classification is marked, what group of fittings have the classification, and when you may or may not open a fitting with that classification.

XRAY fittings are marked with a black X. These closures are secured during conditions XRAY, YOKE, and ZEBRA. You are not to open fittings with this classification without proper authorization. You will find this classification on the following access closures:

- Doors and hatches to storerooms and stowage spaces, including cargo ammunition spaces
- Hatches that are provided with a scuttle and lead to magazines and handling rooms
- Bolted-plate manhole covers
- Escape scuttles not covered elsewhere
- Doors and hatches located only on the weather deck and below that are used to strike down stores and ammunition
- Access to an aircraft fueling station compartment
- Access to escape trunks in machinery spaces
- Access to the arresting gear machinery room
- Access to the eductor room
- Access to the capstan and winch control room
- Access to the stores elevator
- Access to the catapult machinery room
- Access to forced draft blower rooms
- Access to fan rooms

CIRCLE XRAY fittings are marked with a black X inside of a black circle. These modified closures are secured during conditions XRAY, YOKE, and ZEBRA. However, personnel may open these fittings without special authorization when proceeding to battle stations or as required in routine inspection checks. You may open these closures, but you must secure them immediately after use. You will find this classification on the following closures:

- Doors to magazines and handling rooms
- Hatches that do not have a scuttle and lead to magazines and handling rooms
- Access to the missile handling and check-out area compartments
- Scuttles in hatches to the shaft alley, pump rooms, magazines, and handling rooms
- Access to the gas and fuel station and filter rooms
- Access to the oxygen-nitrogen rooms (compressor and producing)
- Access to the switch gear room, ammunition hoist, and elevators
- Access to the underwater log room
- Access to the equipment rooms that are unoccupied
- Scuttles for passing ammunition

YOKE fittings are marked with a black Y. These closures are secured during conditions YOKE and ZEBRA. You must have proper authorization to open fittings with this classification when the ship is at condition YOKE or

ZEBRA. You will find this classification on the following closures:

- Hatches that are provided with a scuttle and lead to shaft alleys and pump rooms
- Alternate accesses to machinery rooms
- Weather deck hatches not classified as XRAY
- Some alternate accesses on the DC deck and above
- Access to the windlass room
- Access to the generator rooms
- Access to the air compressor room
- Access to the air-conditioning machinery room
- Access to the refrigeration machinery room
- Access to the elevator machinery room
- Access to the missile director machinery room
- Access to the chain locker
- Access to the drying room

CIRCLE YOKE fittings are marked with a black Y inside of a black circle. These modified fittings are secured during conditions YOKE and ZEBRA. However, these fittings may also be opened without special authorization when personnel are proceeding to battle stations or as required in routine inspection checks. Again, you must secure these closures immediately after use. You will find this classification on the following closures:

- Hatches that do not have a scuttle and lead to the shaft alley and pump room
- Scuttles in the deck to the shaft alley and pump room
- Doors at the bottom of the trunk to the shaft alley and pump room
- Access to the steering gear power and ram room
- Access to the chill room

ZEBRA fittings are marked with a red Z. These closures are secured during condition ZEBRA. You must have proper authorization to open fittings with this classification when the ship is at condition ZEBRA. You will find this classification on the following closures:

- All remaining doors and hatches for routine access
- Access to all shops, labs, commissary, utility, control, and hospital spaces
- Access to all offices
- Access to equipment rooms occupied when associated control room is in use
- Main access to machinery spaces
- Access to issue rooms
- Access to the steering gear room
- Access to the enclosed operating stations
- Access to hangar and flight deck control stations
- Access to the garbage disposal room
- Access to the trash burner and bin room

CIRCLE ZEBRA fittings are marked with a red Z inside a red circle. These modified fittings are secured during condition ZEBRA. CIRCLE ZEBRA fittings may be opened with the commanding officer's permission during prolonged periods of general quarters. The opening of these fittings allows evolutions such as the preparation and distribution of battle rations, opening of limited sanitary facilities, ventilation of battle stations, and access for aviation personnel to the flight deck. When open, CIRCLE ZEBRA fittings must be guarded so they may be closed immediately if necessary. You will find this classification on the following closures:

- Limited doors or scuttles from the weather deck to the crew's galley

- Doors from aviators and flight crew ready rooms to the flight deck

DOG ZEBRA fittings are marked with a red Z inside a black D. These modified fittings are secured during condition ZEBRA and darken ship conditions. You must have proper authorization to open fittings with this classification when the ship is at either condition ZEBRA or darken ship. You will find this classification on the following closures:

- Doors to the weather deck, excluding those classified XRAY or YOKE, that do not have a darken ship switch or a darken ship curtain

- Airports (portholes)

WILLIAM fittings are marked with a black W. These fittings are kept open during all material conditions. WILLIAM fittings are secured only as necessary to control damage or CBR contamination and to make repairs to the equipment served. You will find this classification on the following fittings:

- Vital sea suction valves that supply the main and auxiliary condensers, fire pumps, and spaces that are manned during conditions XRAY, YOKE, and ZEBRA

- Vital valves that if secured would impair the mobility and fire protection of the ship

CIRCLE WILLIAM fittings are marked with a black W inside a black circle. These fittings are normally kept open, as is the case with WILLIAM fittings. They must, however, be secured to prevent the spread of damage and as a defense measure when a CBR attack is imminent. You will find this classification on the following closures:

- Doors to the pilot house, flag bridge, and signal shelter

- Ventilation systems to main and auxiliary machinery spaces, generator spaces, and other systems and fittings serving spaces in continuous use

If access to a space is through a series of hatches and/or scuttles, all of the closures that provide that access must bear the same classification as that of the space. For example, a pump room is classified as CIRCLE YOKE. This means it is open during condition XRAY and closed during condition YOKE. All hatches, scuttles, and/or doors that provide access to the pump room must also be classified CIRCLE YOKE to allow routine access to the pump room.

When a fan room door must be kept open to supply air to a fan or to exhaust air from it, the door should have the same classification as that of the fan. For example, a fan room containing a YOKE fan has a YOKE door; a room containing YOKE and ZEBRA fans has a ZEBRA door. All other fan room doors are classified XRAY.

A classification has no bearing on the security of a space. A space classified ZEBRA may, for security reasons, be locked during condition YOKE if the space is unattended. However, the locking must be reported to the damage control assistant (DCA) or to the OOD.

Table 3-2 has additional information on damage control closures and classifications.

When material conditions of readiness are being set, the ship's first concern is the requirement for watertight, airtight, firetight, and fumetight integrity. Living conditions and access to spaces are secondary requirements. During long periods at general quarters stations, however, condition ZEBRA may, with the commanding officer's permission, be relaxed to pass battle rations and to allow the crew to use the head facilities. The opening of certain weather deck doors permits natural ventilation to replace the stuffiness at some general quarters stations with fresh air. Condition YOKE may also be modified in a similar manner when appropriate.

Table 3-2.—Damage Control Classifications

SYSTEM OR FITTING	XRAY	YOKE	ZEBRA	WILLIAM
Air escapes	Damage control voids not containing pressure piping.			Damage control voids containing pressure piping.
Air ports		All lens frames.	Dog Zebra: Metal covers.	
Air test fittings	All			
Aviation fuel systems (gasoline and JP-5)	All valves.			
Compressed air	Valves to counter recoil charging to gunmounts, torpedo charging valves, cutout valves to other systems not serving W fittings, elevator pressure tanks, catapult machinery, diesel engine air starting tank and test sets; control valve at compressor to main; hose outlets; compartment testing valves.			All other valves.
Damage control ballast valves	All			
Drainage	All valves in main and secondary drainage systems; bilge suction and overboard discharge valves in machinery spaces; miscellaneous		All deck drain valves, plug cocks, valves, scuppers, and vent valves for plumbing drains; gravity overboard discharge valves from unit	Deck drains and flap valves from operating room.

103.129.1

Table 3-2.—Damage Control Classifications—Continued

SYSTEM OR FITTING	XRAY	YOKE	ZEBRA	WILLIAM
	drainage valves; portable submersible pump overboard discharge connections.		coolers and air conditioning units.	
Firemain, flushing, and sprinkling systems	Valves not segregating into sections and not adversely affecting pressure in main risers; valves actuating main and bilge drainage eductors; sea suction valve in pump room; sprinkling group control valves; washdown system hose valves; submersible pump priming valves; fog foam valves; hangar sprinkling valves; water curtain valves and caps; caps for fixed fog systems. (NOTE: In case firemain and drainage valves are interlocked, firemain valve is X and drainage valve is unclassified.)	Valves for segregation of firemain into port and starboard longitudinal sections, where practicable, and with two or more pumps supplying each section.	Valves for segregation of firemain into four or more sections; firemain valves to flushing system. Valves actuating drainage eductors from quarters; certain cooling water system valves.	All other firemain valves; valves to cooling water systems for vital machinery; sprinkling valves controlled by group valves; sea suction valves for fire pumps in machinery spaces and overboard discharge from gasoline tank.
Fresh water	Filling connection valves.		Root valves above machinery spaces.	Drinking fountains for machinery spaces; gun barrel and rocket launches

103.129.2

Table 3-2.—Damage Control Classifications—Continued

SYSTEM OR FITTING	XRAY	YOKE	ZEBRA	WILLIAM
				cooling systems; all other valves unclassified.
Oil and ballast systems (fuel and JP 5 filling, transfer, and overflow systems)	All valves, except interlocking valves and those in way of pump which shall be unclassified.			
Sounding tube deck plates and valves for voids, oil and water tanks	All			
Ventilation		Windlass and flammable material spaces.	Shaft alley, workshops, living spaces, washrooms, workspaces such as commissary, and utility spaces, issue rooms, rain clothes, athletic gear, chart and registered publication space; storerooms with heat piping. Circle Zebra to galley and one water closet forward and aft.	Circle W for machinery spaces, catapult spaces, pump rooms, aviation fuel maintenance shop, stowage battery shop, generator spaces. Vital spaces if not air conditioned. Controllable fire dampers.
Recirculating air conditioning			Same as ventilated spaces.	Steering gear, control spaces, medical spaces, squadron ready rooms, aviation suit drying rooms, and machinery enclosed operating station missile spaces.

103.129.3

Table 3-2.—Damage Control Classifications—Continued

SYSTEM OR FITTING	XRAY	YOKE	ZEBRA	WILLIAM
Blow-out vent	Conventional ammunition spaces and storerooms. Circle XRAY for shaft alley, nuclear weapons, liquid propellants and toxic chemical agent spaces, and magazine shops.			
Replenishment air			Vital spaces and quarters.	Ready rooms.
Voice tubes and message passing facilities	All			
Miscellaneous AT and WT covers			All	

103.129.4

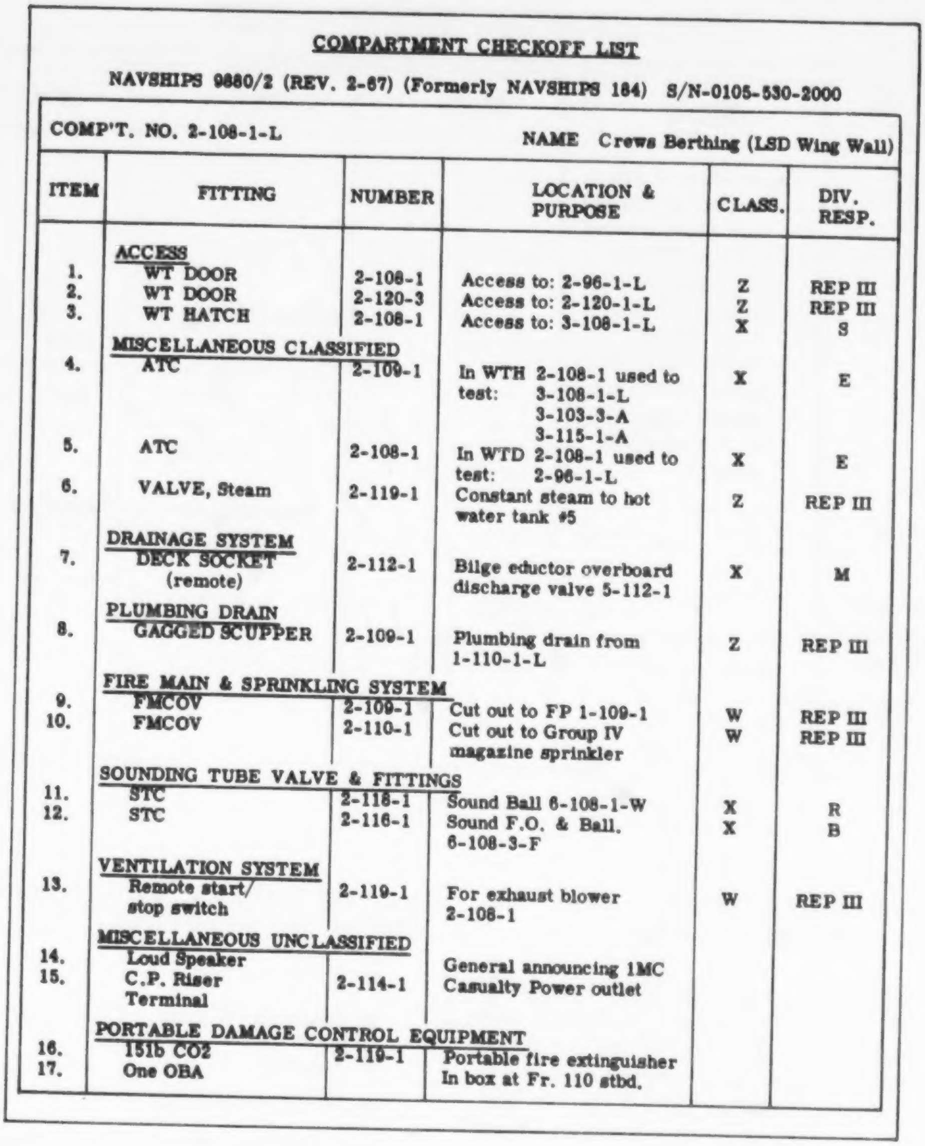
COMPARTMENT CHECKOFF LISTS

Compartment checkoff lists (fig. 3-8) provide an itemized listing of all classified fittings and closures used in damage control to set the specified material condition of readiness. They are originally prepared and furnished by the ship builder's design agent during the construction of a ship or class of ships. After that it is each ship's responsibility to keep the lists current. Follow the guidelines listed in the *Naval Ships' Technical Manual*, chapter 079, volume 2, when you check and update your compartment checkoff lists.

All compartments must have a compartment checkoff list permanently posted within them in clear view of the space access. Weather deck areas that have damage control facilities must also have a compartment checkoff list posted. The compartment name and number are entered on the list along with all classified fittings and certain other damage control facilities in the compartment that are necessary to help damage control personnel in the performance of their duties. The information listed for each of the classified fittings and other facilities on a compartment checkoff lists includes the following:

- Name of item
- Number of item
- Location of item
- Purpose of item
- Classification of item (if classified)
- Division responsible for the proper operation of each fitting

When a compartment has more than one entrance, duplicate compartment checkoff lists must be posted at each entrance. The compartment checkoff lists shall be clearly labeled DUPLICATE. Partial compartment checkoff lists may be desirable when there are alcoves or areas included within a compartment. The partial compartment checkoff list shall be clearly labeled PARTIAL. The item numbers on the partial list must correspond with the numbers on the original list. Compartment checkoff lists for the weather decks, and some other decks, may be divided by sections;



COMPARTMENT CHECKOFF LIST

NAVSHIPS 9880/2 (REV. 2-67) (Formerly NAVSHIPS 184) S/N-0105-530-2000

COMP'T. NO. 2-108-1-L NAME Crews Berthing (LSD Wing Wall)

ITEM	FITTING	NUMBER	LOCATION & PURPOSE	CLASS.	DIV. RESP.
	ACCESS				
1.	WT DOOR	2-108-1	Access to: 2-96-1-L	Z	REP III
2.	WT DOOR	2-120-3	Access to: 2-120-1-L	Z	REP III
3.	WT HATCH	2-108-1	Access to: 3-108-1-L	X	S
	MISCELLANEOUS CLASSIFIED				
4.	ATC	2-109-1	In WTH 2-108-1 used to test: 3-108-1-L 3-103-3-A 3-115-1-A	X	E
5.	ATC	2-108-1	In WTD 2-108-1 used to test: 2-96-1-L	X	E
6.	VALVE, Steam	2-119-1	Constant steam to hot water tank #5	Z	REP III
	DRAINAGE SYSTEM				
7.	DECK SOCKET (remote)	2-112-1	Bilge eductor overboard discharge valve 5-112-1	X	M
	PLUMBING DRAIN				
8.	GAGGED SCUPPER	2-109-1	Plumbing drain from 1-110-1-L	Z	REP III
	FIRE MAIN & SPRINKLING SYSTEM				
9.	FMCOV	2-109-1	Cut out to FP 1-109-1	W	REP III
10.	FMCOV	2-110-1	Cut out to Group IV magazine sprinkler	W	REP III
	SOUNDING TUBE VALVE & FITTINGS				
11.	STC	2-118-1	Sound Ball 6-108-1-W	X	R
12.	STC	2-116-1	Sound F.O. & Ball. 6-108-3-F	X	B
	VENTILATION SYSTEM				
13.	Remote start/ stop switch	2-119-1	For exhaust blower 2-108-1	W	REP III
	MISCELLANEOUS UNCLASSIFIED				
14.	Loud Speaker		General announcing 1MC		
15.	C.P. Riser Terminal	2-114-1	Casualty Power outlet		
	PORTABLE DAMAGE CONTROL EQUIPMENT				
16.	15lb CO2	2-119-1	Portable fire extinguisher		
17.	One OBA		In box at Fr. 110 stbd.		

3.146

Figure 3-8.—Compartment checkoff list.

for example, Main deck, frame 90-120, port side. The DCA maintains a master copy of each original and partial compartment checkoff lists on file in DC central. The DCA, together with the DCPOs, is responsible for ensuring that the compartment checkoff lists are posted and correct.

The individual division officers are responsible for maintaining the list in good physical condition.

The commanding officer, assisted by the DCA, is responsible for filling in the column marked DIVISION RESPONSIBILITY.

The divisions concerned are responsible for securing fittings that are classified as XRAY or YOKE. The ship's repair parties are responsible for securing ZEBRA fittings.

DAMAGE CONTROL CLOSURE LOG

All ships are required to prepare and maintain a damage control closure log (fig. 3-9). To

D.C. CLOSURE LOG

IN ACCORDANCE WITH OPNAVINST 3120.32

PERSON REQUESTING PERMISSION			IDENTIFICATION OF FITTING			OPENED		CLOSED			PERSON GRANTING PERMISSION	
NAME	RATE	DIV.	TYPE	CLASSIFI-CATION	NUMBER	DATE	TIME	DATE	TIME	EST. TIME OPEN	NAME	RANK OR RATE

Figure 3-9.—D.C. closure log record sheet.

complete your General Damage Control PQS, you are required to know what the damage control closure log is and how to use it correctly. Strict discipline must be maintained in the modification of a material condition of readiness. As mentioned before, you must obtain permission before you change a material condition setting in any way. Obtain the permission from the DCA or the OOD. During general quarters, repair party officers control the opening and closing of all fittings in their assigned areas. The repair party officers must keep DCC informed so that the ship's DC closure log can be kept up-to-date.

The closure log is maintained at all times, whether the ship is in port or underway. The closure log is used to show the following:

- Where the existing material condition of readiness has been modified
- The fitting's type, number, and classification
- The name, rate, and division of the person who requested permission to open or close the fitting
- The date and time the fitting was opened or closed
- The date and time the fitting was returned to its specified material condition of readiness setting
- The name and rate/rank of person granting permission

The commanding officer prescribes the limit to which the modification of a material condition of readiness may be approved by the DCA or OOD. Reporting the temporary closing of a fitting that should be open is just as important as reporting the opening of one that should be closed. For example, a ZEBRA watertight hatch that is secured at the time general quarters is sounded could seriously interfere with personnel trying to get to their battle stations.

The damage control closure log is normally kept on the quarterdeck in port, on the bridge at sea, and in DCC during general quarters. However, if your ship has a 24-hour watch in DCC at all times, the closure log will be kept there no matter where the ship is. The closure log is updated when there is a change in the status of a classified closure or fitting. If a classified closure is to remain open for several days, it must be logged open each day. The maximum time a closure or fitting may be logged open is 24 hours.

CARE OF CLOSURES AND FITTINGS

You must keep all closures and fittings in the best possible condition at all times to maintain the ship's watertight integrity feature. Neglected closures and fittings could lead to the loss of your ship.

Faulty gaskets are a main source of leakage through closures. Rubber gaskets are installed in doors, hatches, scuttles, airports, and dogged manholes to provide a tight fit all around. When exposed to oil, grease, heat, or paint, the gaskets begin to deteriorate. Gaskets should be protected from exposure to substances or conditions that cause deterioration. Replace them immediately when they show signs of deterioration. Inspect them frequently to detect hardness, cracks, or permanent set (indentation) greater than 1/8 inch.

Gaskets for bolted manhole covers and other bolted plates differ in size, shape, and material from those used with doors, hatches, scuttles, and dogged manholes. Bolted manhole cover and bolted plate gaskets should be renewed whenever they are found to be in poor condition when the cover is removed. Replacement of these gaskets at this time is particularly important since you cannot tell anything about the condition of the gasket when the manhole/plate is bolted down. The gasket may appear to be perfectly all right when actually it is in a poor condition and is providing a channel for progressive flooding. The replacement gaskets must be of the proper material. The manhole/plate bolts must be tightened up evenly all around. A loosely secured manhole cover can be blown off by an explosion, whereas a cover that is tightly secured will not.

Be careful when moving heavy objects, such as ammunition or machinery, through watertight doors and hatches. If you are careless, you can distort the knife edge or bearing surface of the closure by the impact of the heavy object.

Refer to figure 3-10 while reading the following information.

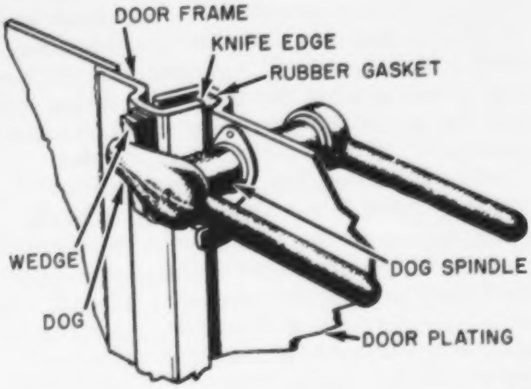


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Figure 3-10.—Watertight door parts.

The compression between a knife edge and a gasket should be checked periodically. If necessary, adjust the closure until the compression specified in the manufacturer's technical manual is reached.

Watertight doors and hatches will retain their efficiency longer and will require less maintenance if you open and close them properly. When you close a door or hatch, secure a dog that is on the OPPOSITE SIDE of the closure from the hinges. Use just enough pressure to keep the door closed. Next, secure two dogs on the hinge side until snug. Then secure all the remaining dogs evenly to ensure an even compression all around. When loosening dogs on watertight doors or hatches, loosen the dogs nearest the hinges first. This will keep the closure from springing and makes it easier to operate the remaining dogs.

A common place for leakage is around dog spindles where the spindles pass through door frames. There is a stuffing box for each dog spindle. The packing in the stuffing box prevents leakage. Inspect the stuffing boxes frequently to ensure that they are in good condition. Tighten the packing gland to give the correct compression of the packing. Repack the dogs when the packing gets hard or deteriorates with age. Occasional adjustment of the dogs is required to compensate for the wearing down of the wedges which the dogs bear down on. When wedges become badly worn, you should either build them up again by gas brazing or replace them.

For a door or hatch to be watertight when it is dogged, the knife edge or bearing surface of the closure must be centered on the gasket. The knife edge must also bear down on the gasket firmly and evenly all around for the closure to be watertight. The door will not be watertight if either the door or the frame is warped. Also, the closure will not be watertight if the door or hatch is not located correctly on its hinges with respect to the door frame. Other factors governing a closure's watertight feature are whether or not the knife edge is straight and even, whether the retainer strips are secured firmly in place, and whether the dogs are adjusted to provide equal pressure on all of the wedges when the dogs are snugly set up. If any of these parts have an incorrect fit, the frame or knife edges may come into contact with the metallic parts of the closure and thus allow the closure to be closed in a non-watertight condition.

Some ventilation ducts have covers to isolate the ventilation system. The gaskets on these covers are subject to the same kinds of failure that access closure gaskets are. Many ventilation closures and valves installed in the ventilation ducts lack tightness because of improper seating. These fittings should be inspected on a regular basis. If you lubricate and maintain the fittings on a routine basis, the fittings will stay in good working condition indefinitely.

Throughout the ship, electric cables pass through many watertight boundaries. The watertight integrity is maintained by passing each cable through a packed stuffing tube, as shown in figure 3-11. Usually, several cables will pass through a deck or bulkhead in a small area known

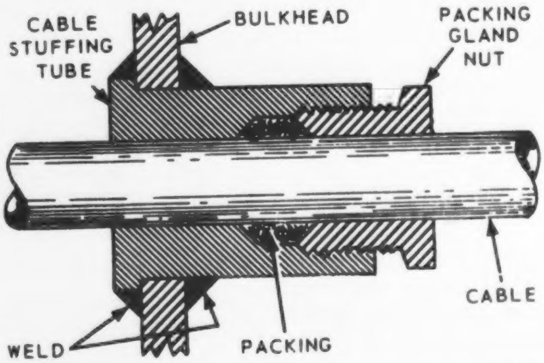

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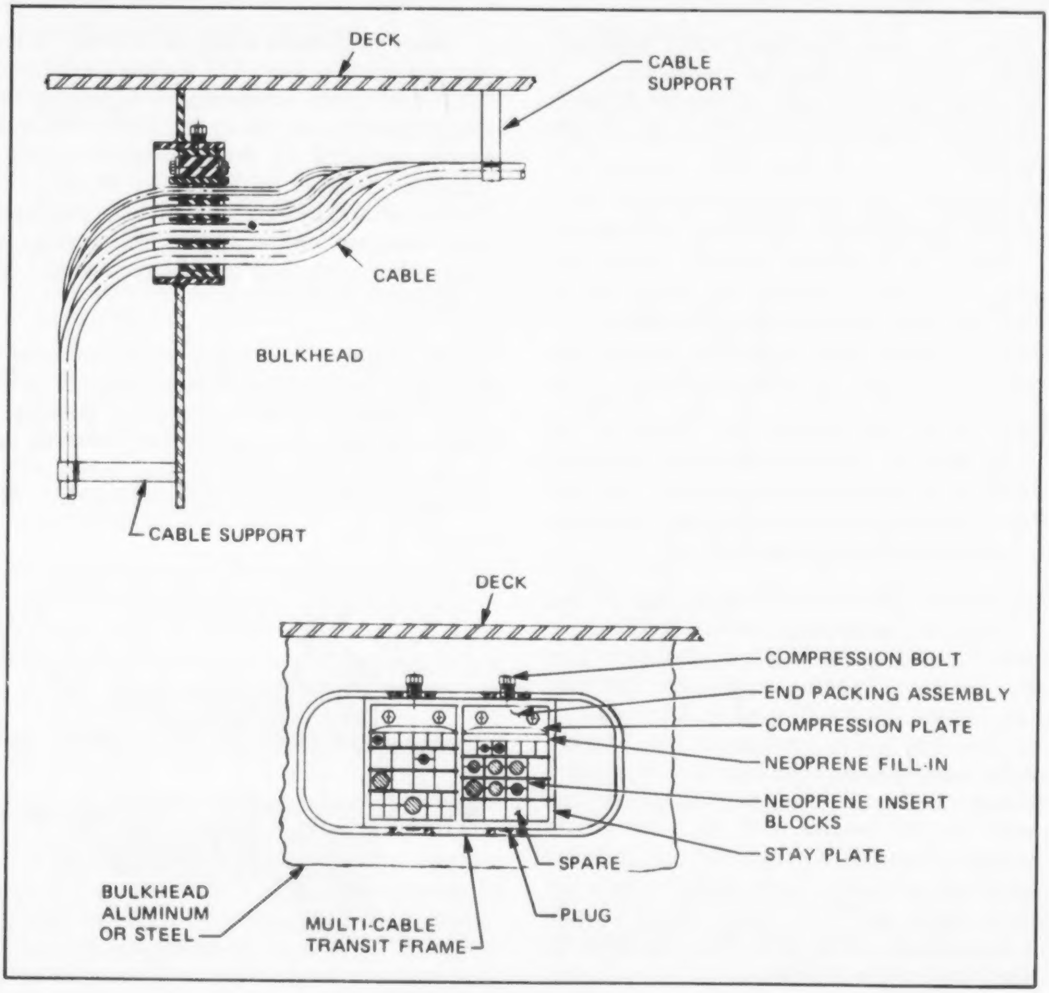
Figure 3-11.—Cable penetration through watertight bulkhead.

as a multi-cable transit frame (fig. 3-12). The stuffing tube nearest the center of the group can be repacked only with a great deal of difficulty. It is vital, however, that the packing be replaced when necessary. If you allow bad packing to remain in the stuffing tube, you will have provided a means for progressive flooding to take place.

Leakage can occur where pipes pass through bulkheads and decks. Various methods are used to make the penetration points watertight. Watertight penetration points reduce the chance of progressive flooding.

Airport covers operate basically the same as doors and hatches. You might need to tighten up the dogs on the airport covers. If the dogs are not tight, the glass lens of the airport can be broken by heavy seas or by the movement of the ship. When you secure an airport cover, be sure to bring the hinge pin of the cover all the way out to the end of the hinge. By doing this, you can avoid the possibility of breaking the cover.

To replace the glass lens, drill and tap holes in the workbench top. These holes will need to be the same size as the holding bolts that are fitted through the securing lugs of the airport frame. By drilling and tapping these holes, you will save a considerable amount of time when replacing the glass lens. Once you secure the airport frame to the workbench, you will be able to unscrew the


DECK
CABLE SUPPORT
CABLE
BULKHEAD
CABLE SUPPORT
DECK
COMPRESSION BOLT
END PACKING ASSEMBLY
COMPRESSION PLATE
NEOPRENE FILL-IN
NEOPRENE INSERT BLOCKS
STAY PLATE
SPARE
PLUG
BULKHEAD ALUMINUM OR STEEL
MULTI-CABLE TRANSIT FRAME

8.467

Figure 3-12.—Multi-cable transit frame.

retaining ring. After you remove the old glass lens, clean the threads of the frame and the retaining ring. If the frame and ring are made of composition material, apply a light coating of oil or grease to the threads. Before you insert a new glass, embed the edges of the glass in red lead putty or another approved material. When you secure the retaining ring, the putty is forced out evenly all around the glass lens, thereby ensuring a tight fit.

Safety is a major concern in whatever you do. When opening a closure, you can protect yourself by standing on the opposite side from the hinges and loosening the dogs nearest the hinge first. You will then find it easier to loosen the other dogs, and you will not get hurt by the door if there is an explosion within the compartment. The hinges help to keep the door from blowing open. If you are on the hinge side of the door when an explosion occurs, you will be caught between the door and the bulkhead.

Each closure has a safety device. Some hatches have stanchions; others have locking latches. Both devices use toggle pins to secure them in place. Be sure that the toggle pins are in place at all times when the hatch is open. Watertight scuttles have a safety device known as a bracing link assembly. Make sure that the bracing link assembly is in good operating condition at all times. When exiting a compartment through a scuttle, do not grab hold of the scuttle to pull yourself through. If the bracing link assembly fails to lock, the scuttle will fall on your head or fingers, causing considerable injury. A door catch is installed for each shipboard door. When a door is to be left open for a period of time, use the door catch. The movement of the ship could cause the door to slam shut. A door slamming shut will damage the door's gasket and could seriously injure a person. Most personnel injuries are not caused by the closure's design, but rather by an individual's carelessness.

METHODS OF CHECKING WATERTIGHT INTEGRITY

Watertight integrity features are built into naval ships. There must be regular inspections conducted on the ship and its watertight integrity features. The ship's planned maintenance system (PMS) gives specific details for conducting the compartment tests and inspections. The *Naval Ships' Technical Manual*, chapter 9880, section IV, also covers various compartment tests and inspections. A Schedule of Watertight Integrity Tests and Inspections is maintained in the ship's damage control library. Refer to the above references when you schedule and conduct the required tests and inspections.

VISUAL INSPECTION

Often you can discover holes or cracks in watertight bulkheads and decks by conducting a thorough visual inspection. If a compartment contains oil, water, or some other liquid, any leakage will be evident. Other sources for leakage include loose rivet heads, poorly caulked plate laps or stiffeners, and poorly caulked bounding angles. All leaks should be repaired as soon as possible to re-establish the ship's watertight integrity. If the repairs are beyond the capability of the ship's force repair personnel (Hull Technicians), the work should be included in the work package for the next shipyard, tender, or repair ship availability.

You will, at specified intervals conduct a visual inspection for light leaks within most compartments on the ship. To make this inspection, completely close off the compartment and secure all lighting within the compartment. Have another person (an observer) stay inside the darkened compartment to look for light leaks. Then you will need to ensure that lighting is on in the surrounding spaces. As a rule, the light from the surrounding compartments will allow the observer to locate any serious defects. However, you might need to use portable lights to provide a higher level of illumination in some areas. The observer will also need a portable light to transit the darkened space safely.

The visual inspection for light leaks is particularly important for those compartments that cannot be tested by air pressure because of permanent openings to the topside. Compartments that will have a visual inspection include engine rooms, firerooms, other machinery spaces, and all compartments on the main deck and above.

COMPARTMENT AIR TEST

The Schedule of Watertight Integrity Tests and Inspections is issued by NAVSEA for each ship. This schedule contains information on each watertight compartment and the type of test used to determine the compartment's tightness. Compartments designated for air testing are scheduled so that all such compartments are tested once every 18 months for ships at least 12 years old. For ships that are less than 12 years old, the compartments are tested once every 36 months. Compartments that are designated for air testing are provided with fittings for attaching the air test set. In the case of tanks, you may use sounding tubes or air escapes to connect the air test set. Figure 3-13 shows the air test set that is provided for shipboard use. The manufacturer's technical manual, provided with each set, gives detailed instructions for operating the air test set.

The information contained in the ship's Schedule of Watertight Integrity Tests and Inspections must be strictly adhered to when conducting compartment air tests. The air test pressure listed in the schedule must NEVER be exceeded. You can seriously damage the structures and boundaries of the compartment being tested if the recommended pressure is exceeded.

Before starting an air test, you need to conduct a visual inspection of the compartment and repair all the leaks that you find. Notify the engineer officer, the DCA, and the OOD of your intent to conduct a compartment air test and which compartments will be involved. Also, have an Electrician's Mate (EM) assist in de-energizing the electrical push-button alarms and remote-controlled valves for sprinkling, flooding, or counterflooding systems if any are installed in the compartment to be tested. These devices have diaphragm covers and would be activated when the air test pressure is admitted to the compartment unless they had been previously de-energized.

All fittings that serve the compartment must be secured or blanked off before the air test is conducted. If any rotating shafts or other moving parts penetrate the bulkheads, you must tighten the packing before conducting the air test to maintain the air pressure.

Make sure that the crew is aware of the compartment air test being conducted. Post signs at every possible access to the compartment(s) being tested. If an observer is stationed inside the compartment during the compartment air test, each access to the compartment must have someone posted at the access closure. The guards are to prevent the access closure from being opened until the excessive pressure within the compartment is relieved. The air test pressure used in a compartment air test is relatively low. However, a dangerous total force can be

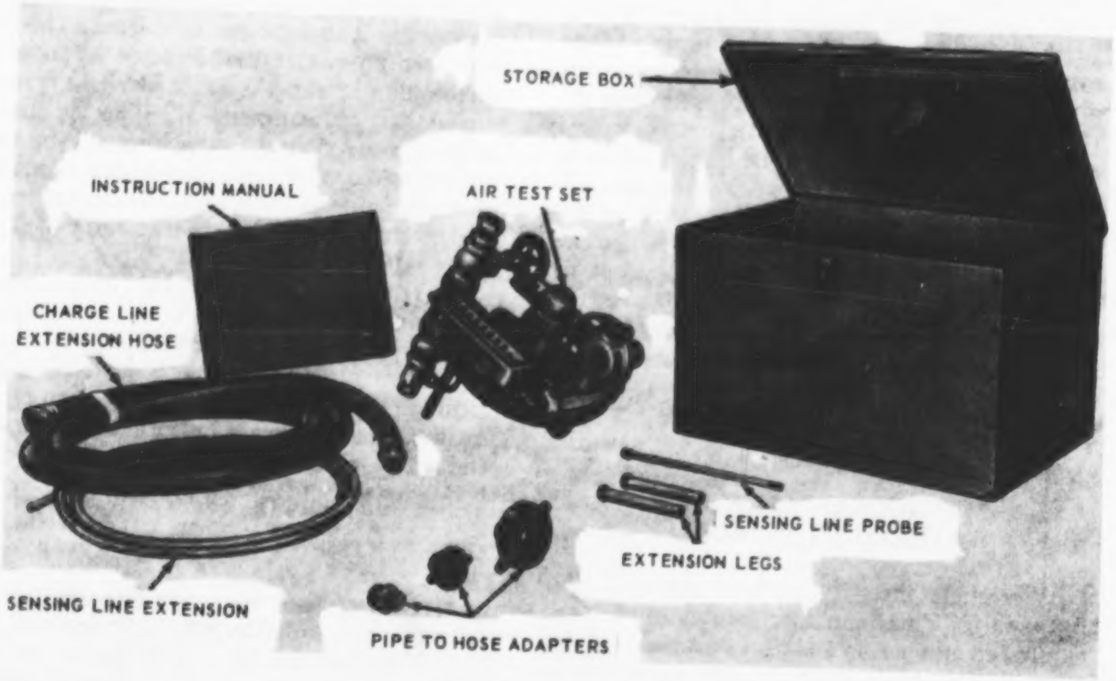


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Figure 3-13.—Air test set.

developed on quick-acting doors and hatches. Personnel should be instructed not to attempt to open quick-acting doors or hatches when a compartment is under air test. A person opening these doors or hatches while the compartment is under pressure could sustain severe injuries.

When conducting a compartment air test on a large compartment, use as many personnel as required to check for leaks. The personnel involved with the test need to maintain communication with each other. The X40J (salt and pepper) rig can be used, allowing you to have an isolated circuit without interruptions.

When you are conducting a compartment air test, any loss of pressure in excess of the allowable drop listed in the schedule over the specified period of time indicates deterioration of the watertight integrity of the compartment. If corrective measures are beyond the capacity of ship's force, the compartment must be listed as UNSATISFACTORY. You must then request that repairs be completed during the next availability.

While the compartment is under test, leaks will be disclosed by hissing or whistling noises as the air escapes. All leaks should be located, marked, and listed for corrective action. You should repair all leaks that you found and then test the compartment again. If the allowable pressure drop is again exceeded on this test, apply a soap solution to the boundaries of the compartment and to all joints, fittings, and closures. When the air pressure is applied, bubbles will be formed by escaping air, thus indicating the location of the leaks.

The observer inside the compartment will have a lighted candle. As the observer goes over areas where leaks are suspected, the deflection of the flame will indicate the location of leaks.

Upon completion of the compartment air test, relieve the air pressure in the compartment. Be sure that all caps for the air test fittings are replaced. These caps are classified XRAY. Ensure that all temporary closures are removed from overflows, air escapes, and air vents in magazines and fuel oil tanks. The boundaries are sure to be ruptured when the space is filled or flooded if these vents and escapes are left closed. Then make the appropriate entries in the watertight integrity log if your ship has one.

SOUNDING AND SECURITY PATROL WATCH

The sounding and security patrol watch is also known as the damage control patrol watch. It is essential that only those who are well indoctrinated be assigned this watch. As the sounding and security patrol, you will follow an irregular route while conducting a continuous security inspection of all spaces. Some spaces will have a watch posted within them or be designated as a limited or exclusive area. In such cases, you will not enter the space, but you will inspect the surrounding areas. While making your rounds, you will inspect all watertight airports, doors, hatches, scuttles, and other closures to ensure that there are no violations of the material condition of readiness that is set. You will also be checking for fire hazards, fire, flooding, theft, sabotage, or other irregularities that would affect the physical security of the ship. You will check for leakage of the firemain, fresh water, and other piping systems. If you find a hazardous or potentially hazardous condition, report it immediately to the OOD and to DCC. To help determine whether voids or tanks are flooded, you will take soundings and you can compare each day's draft report with the draft report of the preceeding day.

SOUNDINGS

One of your duties as a Damage Controlman is to determine the amount of liquid in certain compartments, tanks, and voids. You do this by taking soundings at regular intervals when standing the sounding and security watch. You must know where all the sounding tubes are located and also follow the correct procedures for taking soundings.

A sounding tube is usually made of 1 1/2-inch pipe. The lower end of the tube is located near the lowest point of the compartment, tank, or void that the tube serves. The upper end of the tube is usually located on the main or second deck and is secured with a threaded plug or cap.

If the tube extends above the deck, it will have a gate valve installed in the pipe. These tubes normally serve spaces under the machinery spaces. The sounding tubes are normally straight, but they may have a slight curve because of obstructions.

Soundings are taken with either a sounding rod or a sounding tape, whichever is provided. The sounding rod is 2 feet long and is made of 6-inch lengths of 1/2-inch steel rod. The rod is lowered down the tube by either a chain or a line. The sounding tape is a steel tape that is coiled on a reel. The reel can be held in your hand while you lower the tape. The tape is weighted at the end so it can easily be lowered into the sounding tube.

Soundings are taken in specified peak tanks, ballast tanks, cofferdams, voids, storerooms, and other similar spaces. Although soundings are taken on a regular schedule, they may also be taken at any other time when considered necessary for the safety of the ship.

Before taking a sounding, dry the rod or tape and coat it with chalk. Then lower it down the tube until it touches bottom. Do not drop the rod or tape to the bottom. Lower it slowly so it hits the bottom without being damaged. Then bring it back up immediately. If the ship is rolling, try to lower and hoist the rod or tape rapidly while the ship is on an even keel.

Immediately after taking a sounding, replace the cap or plug and tighten it with a wrench. If a gate valve is installed, close the valve. Next, record the depth of the liquid on the sounding record sheet. If a normally dry compartment shows any liquid, immediately notify the OOD and either the DCA or the engineer officer.

You must use certain precautions when taking soundings. Carefully remove the plug or cap from the upper end of a sounding tube in such a way that the cap is always under control. Back it off slowly and listen for the hiss of escaping air. If a rush of air escapes around the threads while the cap is still under control, STOP REMOVING THE CAP. The escape of air is a sign that the compartment is partially flooded. A trickle of water around the threads indicates that the compartment is completely flooded. In either case, secure the cap and report the situation immediately.

DRAFT AND DRAFT MARKS

The Displacement and Other Curves are a set of curves that shows the various properties of the shape of the underwater body of a ship. The Displacement and Other Curves are also referred to as Curves of Form. The curves are made up by either NAVSEA or a design activity, from the design lines of the ship. The stability officer uses the Curves of Form to calculate and maintain stability. In order to read the Curves of Form, it is necessary to obtain the averaged mean draft periodically. The mean draft of a ship is the average of the drafts at the forward and aft perpendiculars. All ships have at least two sets of marks (one port, one starboard) at the bow and two sets of marks (one port, one starboard) at the stern. Some ships have two sets of marks (one port, one starboard) at the amidships point. The amidship marks give a direct reading of the mean draft. All of these draft marks are known as CALCULATION draft marks. They indicate the distance from the bottom of the keel to the waterline.

Ships having projections below the keel are usually provided with additional sets of NAVIGATIONAL draft marks. These marks indicate the distance from the lowest projection of the hull to the waterline.

Calculation draft marks and navigational draft marks are shown in figure 3-14.

Calculation draft marks are used to determine displacement and other properties of the ship for stability and damage control purposes. Calculation draft marks are marked on the hull with Roman numerals. The marks are 3 inches tall. The bottom of the mark indicates the number of feet of the draft in feet. The top of the mark indicates the number of feet of the draft plus 3 inches. A horizontal bar is inserted between each Roman numeral. The bottom of the bar is the half-foot mark. The bar is 1 inch tall. Therefore, for a draft of 13 feet, the waterline will be at the bottom of the Roman numeral XIII. For a draft of 13 feet 7 inches, the waterline will be at the top of the horizontal bar that is between the Roman numerals XIII and XIV.

Navigational draft marks are used primarily by the ship's navigator. Navigational marks are located on the hull and are Arabic numbers that are 6 inches tall. The bottom of an Arabic number

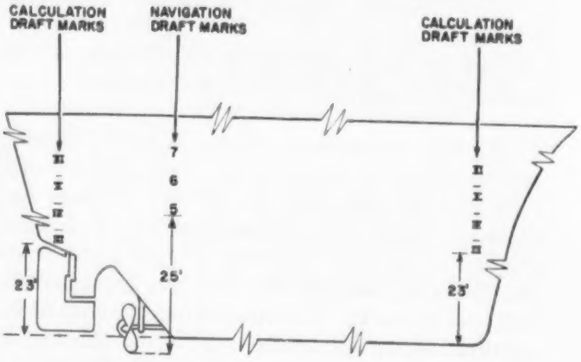

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Figure 3-14.—Draft diagram.

indicates the number of feet of the draft in feet. The top of an Arabic number indicates the number of feet of the draft plus 6 inches. Navigational draft marks greater than 9 feet are indicated by the last digit only. Therefore, for a draft of 25 feet, the waterline will be at the bottom of a 5. For a draft of 25 feet 6 inches, the waterline will be at the top of a 5.

Taking the Draft

The draft is taken daily, before getting under way, upon anchoring, mooring, or entering drydock, before and after fueling, and at any other time when required by the commanding officer. A considerable error can be made if the draft readings are taken when the sea is choppy or when the ship is under way.

The draft is read in feet and inches and is entered on a form provided for that purpose. Inches of draft must be estimated as closely as possible. To obtain an accurate reading that will not be affected by a list, the mean draft is calculated as follows:

1. Read the draft at the bow on the port and the starboard sides. Average these readings and record the results.
2. Read the draft at the stern on the port and the starboard sides. Average these readings and record the results.
3. Obtain the mean draft by adding the average draft forward to the average draft aft and then dividing the sum by 2.

Limiting Draft Marks

When a ship operates at excessively heavy displacements, there are adverse effects on speed, cruising radius, stability, strength, and freeboard.

Limiting draft marks are installed on the ship's hull near the draft numerals or amidships. These marks indicate the draft that is not to be exceeded without endangering the ship's ability to survive damage or heavy weather. Under extreme circumstances, however, the limiting draft mark may be exceeded if the commanding officer decides that the circumstances warrant the risk. Figure 3-15 shows the limiting draft mark used on naval ships.

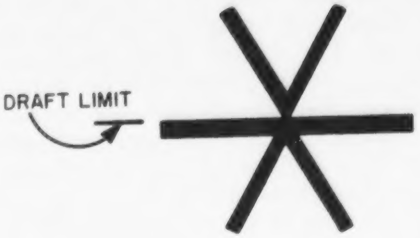

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Figure 3-15.—Limiting draft mark.

Plimsoll Marks

The Plimsoll mark (fig. 3-16) is a standard marking painted on the sides of merchant ships and some naval auxiliary ships. These marks indicate the maximum draft allowed by law in various waters. The load lines indicate the drafts at which the ship will have a safe reserve of buoyancy. The circular symbol with the horizontal line is usually placed amidships. The horizontal line indicates the same draft that the S line of the symbol to the right of the circle indicates. The abbreviations used in figure 3-16 stand for the following:

TF—Maximum draft, tropical (freshwater)

F—Maximum draft (freshwater)

T—Maximum draft, tropical (salt water)

S—Maximum draft, summer (salt water)

W—Maximum draft, winter (salt water)

WNA—Maximum draft, winter, North Atlantic (salt water)

Internal Draft Indicators

Internal draft gauges and indicators are frequently installed in large ships. The ship's draft

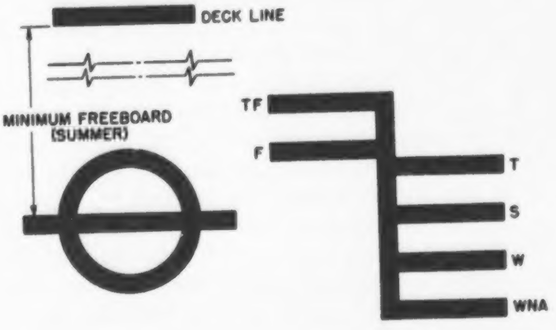

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Figure 3-16.—Plimsoll mark.

can be read from within the ship by using a remote draft gauge in combination with a profile draft indicator. The remote draft gauge provides information to DCC relative to the draft of the ship at a predetermined point. The instrument is located in DCC or in an adjacent compartment. If the remote draft gauge is located in a compartment other than DCC, communication between the two locations is maintained through the 2JZ circuit.

The profile draft indicator is located in DCC. It is mounted in gimbals, which permits the indicator to swing freely with the rolling and listing of the ship. An indicator card, on which is engraved the ship's outline, moves through an angle five times as great as the actual angle of fore-and-aft trim. The outline of the ship on the card is purposely distorted so that the vertical scale of reduction is one-fifth that of the horizontal scale. Thus small angles of trim may be easily detected and read on the indicator card. Information obtained from the remote draft gauge is used in adjusting the "actual waterline" on the profile draft indicator.

Ship Clinometers

To understand the use of ship clinometers, you need to know the meaning of the following terms that refer to the ship's motion or position:

HEEL is a general term that refers to any athwartships inclination, temporary or permanent. In heeling, the ship rotates about a fore-and-aft axis.

ROLL is the alternate heeling from side to side of a ship.

LIST is the term used to describe a permanent angle of heel taken on by a ship. In a seaway, the listing ship will roll about its angle of list. When the ship returns to calm water, it will resume the angle of list. As used here, the term *list* refers to a permanent angle of inclination. A ship may be caused to heel and to remain inclined for more or less enduring intervals by such influences as strong wind pressures from one side, carrying a constant rudder angle, or by large ragged "fins" turned out from a torpedo hole. The term *list* is not intended to refer to such inclinations.

TRIM is the difference between the forward draft and the after draft. When the draft aft is greater than the draft forward, the ship is said to be trimmed by the stern. When the draft forward is greater than the draft aft, the ship is said to be trimmed by the bow.

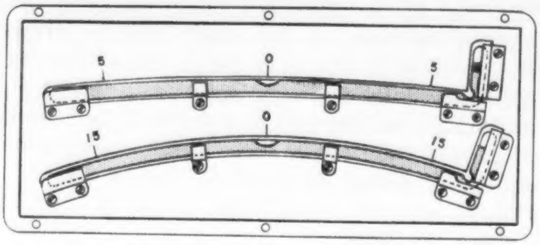

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Figure 3-17.—Typical clinometer board trim indicator.

PITCH is the fore-and-aft motion of a ship about its athwarthships axis.

A clinometer is a spirit level device consisting of a curved glass tube mounted on a calibrated board, as shown in figures 3-17 and 3-18. The glass tube is hermetically sealed.

The Navy uses four types of clinometer tubes, which are designated type A, type B, type C, and type E. Types A and B are employed as trim indicators only. Type A has a long radius of curvature, and the radius of type B is approximately one-third that of type A. Types C and E are used as heel indicators only.

On surface ships, clinometers are installed at vital stations such as DCC, chart house, pilot house, navigating bridge, and main engine control.

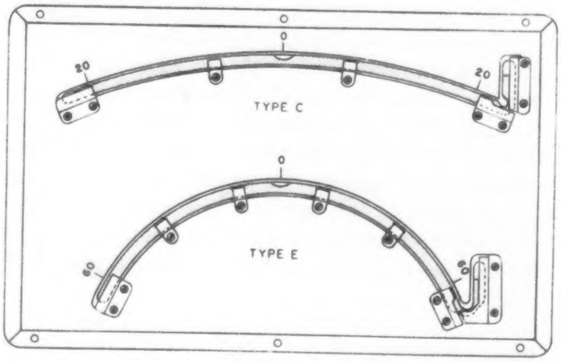

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Figure 3-18.—Typical clinometer board heel indicator.

A clinometer is most accurate under static conditions—that is, at fixed angles of heel or list or trim. For usual angles of roll and pitch, the clinometer is accurate enough for most purposes. At large angles of roll, however, a condition of resonance may exist between the ship's motion and the motion of the fluid in the clinometer. In such circumstances, an excessively large angle of roll may be indicated on the clinometer. A clinometer is not accurate enough to measure inclination when conducting the inclining experiment.

An inclining experiment is conducted on several ships of each class. This experiment is designed to determine the vertical height of the ship's center of gravity above the keel. The information obtained will be distributed to each ship within the class. This information is used to help determine the ship's stability during various loading condition.

Figures 3-19, 3-20, and 3-21 show typical clinometer reactions to changes in the ship's attitude.

The sounding and security patrol is one of the most important watches aboard ship. When you stand this watch, you need to stay alert. Personnel standing this watch have prevented serious damage by discovering fires and floods before they were able to get out of control.

SUMMARY

In this chapter, you were introduced to ship compartmentation, material condition of readiness, compartment checkoff lists, and the DC closure log, along with the relationship of each to watertight integrity. As a Damage Controlman, you will use the information learned in this chapter in the daily performance of your duties. You need to have a good understanding of each topic that has been discussed. If you did not understand any of these topics, go back and review them now before you move on the next chapter.

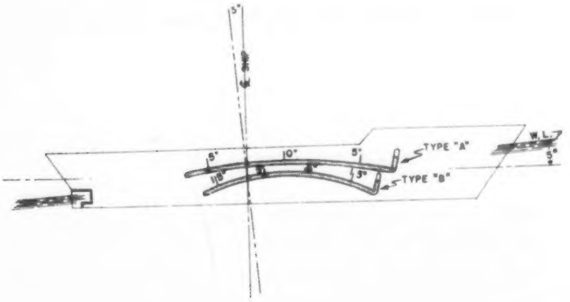

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Figure 3-19.—Trim by bow.

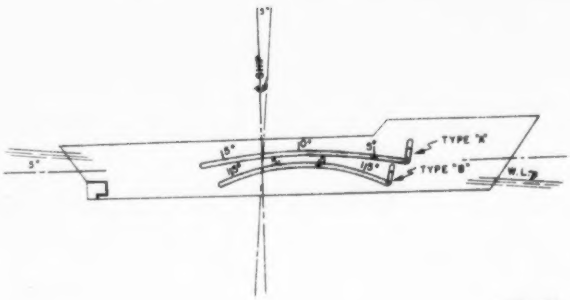

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Figure 3-20.—Trim by stern.

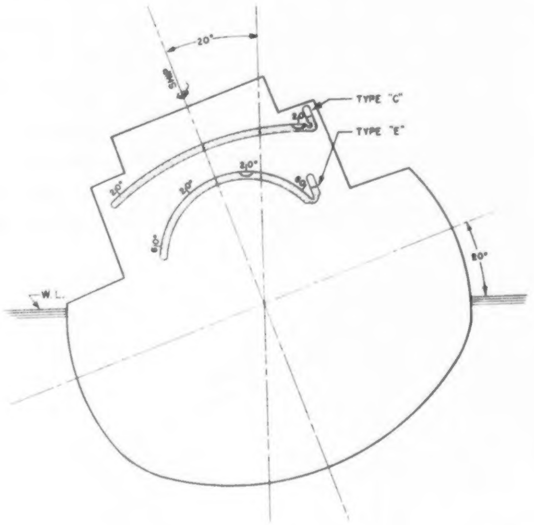

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Figure 3-21.—Heel to port.

CHAPTER 4

FUNDAMENTALS OF FIRE FIGHTING

Fire is a constant potential hazard aboard ship. You must take all possible measures to prevent fires from starting. If a fire does start, you must immediately report the fire to the officer of the deck and then extinguish it rapidly. Often a fire will start in conjunction with other damage caused by enemy action, storms, or an accident. Some fires are caused by Hull Maintenance Technicians doing welding, brazing, or cutting. Fires must be extinguished rapidly. Otherwise, they could easily cause more damage than the initial casualty. In fact, a fire could cause the loss of a ship even after the original damage has been repaired or minimized.

As a Damage Controlman, you will need to know a great deal about fires. You need to know how to identify the different classes of fires, how to extinguish them, and how to use and maintain the fire fighting equipment systems and equipment. The more you learn, the more you will be able to contribute effectively to the safety of your ship.

In this chapter, we deal with the fundamentals of fire fighting. These include the nature of fire, the classification of fires, the fundamentals of extinguishment, and the extinguishing agents used.

FIRE COMPONENTS

Three components are required for a fire. These are a combustible material, a sufficiently high temperature, and a supply of oxygen. You will hear these components referred to as the *fire triangle* consisting of fuel, heat, and oxygen (fig. 4-1). Fires are generally controlled and extinguished by eliminating one side of the fire triangle. That is, if you remove either the fuel, heat, or oxygen, you can prevent or extinguish a fire. We will discuss the extinguishment of fires later in this chapter.

HEAT

Fire is also called burning or combustion. This is a rapid chemical reaction that releases energy in the form of light and noticeable heat. Most combustion involves rapid OXIDATION. Oxidation is the chemical reaction by which oxygen combines chemically with the elements of the burning substance.

Even when oxidation proceeds slowly, such as a piece of iron rusting, a small amount of heat is generated. However, this heat usually dissipates before there is any noticeable rise in the temperature of the material being oxidized. With certain types of materials, slow oxidation can turn into fast oxidation (fire) if the heat is not dissipated. These materials are normally stowed in a confined space where the heat of oxidation cannot be dissipated rapidly enough. This is known as *spontaneous combustion*. Materials such as rags or papers that are soaked with either animal fats, vegetable fats, paints, or solvents are particularly subject to spontaneous combustion.

For a combustible fuel or substance to catch on fire, it must have an ignition source and be hot enough to burn. The lowest temperature at

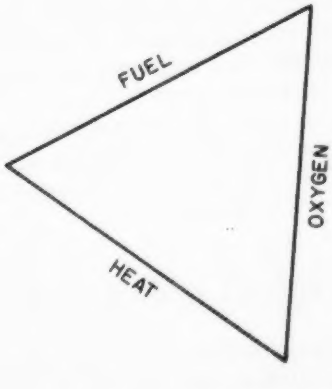

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Figure 4-1.—The fire triangle.

which a flammable substance gives off vapors that will burn when a flame or spark is applied is known as the FLASH POINT. THE FIRE POINT is the temperature at which the fuel will continue to burn after it has been ignited. The fire point is usually a few degrees higher than the flash point. The *auto-ignition* or *self-ignition point* is the lowest temperature to which a substance must be heated to give off vapors that will burn without the application of a spark or flame. In other words, the auto-ignition point is the temperature at which spontaneous combustion occurs. The auto-ignition point is usually at a much higher temperature than the fire point.

The range between the smallest and the largest amounts of vapor in a given quantity of air that will burn or explode when ignited is called the *flammable range* or the *explosive range*. For example, let us say that a substance has a flammable or explosive range of 1 to 12 percent. This means that either a fire or an explosion can occur if the atmosphere contains more than 1 percent but less than 12 percent of the vapor of this substance. In general, the percentages referred to in connection with flammable or explosive ranges are percentages by volume.

FUEL

One of the components of the fire triangle is fuel. Fuels take on a wide variety of characteristics. A fuel may be a solid, liquid, or even a vapor. Some of the fuels you will come into contact with are rags, paper, wood, oil, paint, solvents, and magnesium metals. This is by no means a complete list, but only examples.

OXYGEN

The air that you breath contains 20.8 percent oxygen. All fires need oxygen to continue to burn. Some fires will burn with only 6 percent oxygen. However, there are some fires that will produce their own oxygen. Further discussion on oxygen and its association with the control and extinguishment of fires will be covered in the appropriate sections of this chapter.

FIRE CLASSIFCATIONS

Fires are classified according to the nature of the combustibles (or fuels) involved. The classification of any particular fire is of great importance since it determines the manner in which the fire must be extinguished. Fires are classified as being either class ALFA, class BRAVO, class CHARLIE, or class DELTA fires.

Class ALFA (A) fires are those that occur in such ordinary combustible materials as wood, cloth, paper, upholstery, and similar materials. Class A fires are usually extinguished with water, using high or low velocity fog or solid streams. Class A fires leave embers or ashes and must always be overhauled.

Class BRAVO (B) fires are those that occur in the vapor-air mixture over the surface of flammable liquids, such as gasoline, jet-fuels, diesel oil, fuel oil, paints, thinners, solvents, lubricating oils, and greases. Dry chemical (PKP), aqueous film forming foam (AFFF), Halon 1301, carbon dioxide (CO_2), or water fog can be used to extinguish class B fires. The agent you use will depend upon the circumstances of the fire.

Class CHARLIE (C) fires are those which occur in electrical equipment. Nonconducting extinguishing agents, such as PKP, CO_2, and Halon 1301 are used to extinguish class C fires. Carbon dioxide and Halon 1301 are preferred because they leave no residue.

Class DELTA (D) fires occur in combustible metals, such as magnesium, titanium, and sodium. Special techniques have been developed to control this type of fire. If possible, the burning material should be jettisoned overboard. Most class D fires are fought by applying large amounts of water on the burning material to cool it down below its ignition temperature. However, magnesium fires can be smothered by covering the magnesium with lots of dry sand.

THE EFFECTS OF FIRE

A burning substance produces a number of chemical reactions. These reactions produce flames, heat, smoke, and number of gases and other combustion products. The gases and combustion products will reduce the amount of oxygen available for breathing. All of these effects are vitally important to you as a fire fighter. You must be prepared to protect yourself against them.

FLAME, HEAT, AND SMOKE

Personnel must be protected from the flames, heat, and smoke to avoid injuries or loss of life. Before you enter a compartment or area where there is a fire, you need to be dressed-out properly.

You will need to tuck your pants into your socks, button the collar on your shirt, and put on a helmet. Wear any other protective clothing prescribed by current directives. If you are a nozzleman or hoseman, you will also need to wear protective gloves and an oxygen breathing apparatus (OBA). The flames and heat from a fire can be intense. However, if you are dressed out properly and maintain adequate distance, you can minimize your chances of getting burned. The smoke will make it hard to see and breath. However, you can cope with these problems by wearing an OBA and a headlamp.

GASES

Some of the gases produced by a fire are toxic (poisonous). Other gases although nontoxic are dangerous in other ways. We will discuss briefly some of the more common gases that are associated with fires.

Carbon Monoxide

Carbon monoxide (CO) is produced by a fire when there is not enough oxygen present for the complete combustion of all of the carbon in the burning material. CO is a colorless, odorless, tasteless, and nonirritating gas. However, it can cause death even in small concentrations. A person who is exposed to a concentration of 1.28 percent CO in air will become unconscious after two or three breaths. They will probably die in 1 to 3 minutes if left in the area. CO also has a wide explosive range. If CO is mixed with air in the amount of 12.5 to 74 percent by volume, an open flame or even a spark will set off a violent explosion.

Carbon Dioxide

Carbon dioxide (CO_2) is produced by a fire when there is complete combustion of all of the carbon in the burning material. CO_2 is a colorless and odorless gas. Although CO_2 is not poisonous, unconsciousness can result from prolonged exposure at 10 percent volume and higher. Above 11 percent volume, unconsciousness can occur in one minute or less. In a sufficient quantity, death could occur, since CO_2 does not provide any oxygen to breathe. The danger of asphyxiation should not be taken lightly; CO_2 does not give any warning of its presence, even when it is present in dangerous amounts. It does not support combustion and it does not form explosive mixtures with any substances. Because of these characteristics, CO_2 is very useful as a fire extinguishing agent. It is also used for inerting fuel oil tanks, gasoline tanks, and similar spaces.

Hydrogen Sulfide

Hydrogen sulfide (H_2S) is generated in some fires. It is also produced by the rotting of foods, cloth, leather, sewage, and other organic materials. H_2S can be produced within 6 to 12 hours. Use caution when fighting fires around sewage systems and in spaces where there has been a sewage spill. H_2S is a colorless gas that smells like rotten eggs. Air that contains 4.3 to 46 percent H_2S is violently explosive in the presence of a flame. H_2S is extremely poisonous if breathed, even in concentrations as low as 20 ppm. You may rapidly become unconscious, stop breathing, and possibly die after one breath in an atmosphere that contains 1,000 to 2,000 ppm of H_2S.

Hydrogen Chloride

Hydrogen chloride (HCl) is emitted by fire-retardant paper (Federal Specification UU-P-268) when the paper is exposed to temperatures of 200 °F (93 °C). Also, Flexifloor tile MT 202 (Butyl rubber MIL-M-15562) exposed to temperatures of 400 °F (204 °C) will emit HCl. The level of HCl emitted is four times the authorized safe level of 5 ppm. Breathing concentrations of 1500 ppm is fatal in just a few minutes.

Hydrogen chloride is a colorless, nonflammable gas, which is soluble in water. The gas could be found in a mist form. It is corrosive to the eyes, skin, and mucous membranes. If you have a fire in a compartment where fire-retardant paper or tile is located, be sure to wear an OBA until the compartment is tested and found safe for personnel without an OBA.

Phosphine

Phosphine (PH_3) is also emitted by fire-retardant paper (Federal Specification UU-P-268) when the paper is exposed to temperatures of 200 °F (93 °C). Flexifloor tile MT 202, (Butyl rubber MIL-M-15562,) will also emit PH_3 when exposed to temperatures of 400 °F (204 °C). The level of PH_3 emitted is 23 times the authorized safe level of 0.3 ppm.

Phosphine is a colorless gas that has an odor of decaying fish. It is soluble in water and in organic solvents, and it ignites at a low temperature. The odor of the gas may be nauseating. When PH_3 is suspected, wear an OBA until atmospheric tests show that the area is safe.

INSUFFICIENT OXYGEN

A fire in a closed compartment may cause an inadequate supply of oxygen for breathing. An enormous amount of oxygen is used by the fire itself, leaving relatively little oxygen to breathe. The amount of oxygen normally present in the air is 20.8 percent. You breathe and work best with this amount of oxygen. When a space is suspected of having an insufficient amount of oxygen, wear an OBA. Keep the OBA on until atmospheric tests show that oxygen content is at least 20 percent and no more than 22 percent by volume.

FIRE EXTINGUISHMENT

In general, fires may be extinguished by removing one side of the fire triangle (fuel, heat, or oxygen) or by slowing down the rate of combustion. The method or methods used in any specific instance will depend upon the classification of the fire and the circumstances surrounding the fire.

THE REMOVAL OF FUEL

Although it is not usually possible to actually remove the fuel to extinguish a fire, there may be circumstances in which it is possible. If part of the fuel that is near or actually on fire can safely be jettisoned over the side, do so as soon as possible. Damage control parties must stand ready at all times to shift combustibles to safe areas. Take whatever measures possible to keep additional fuel away from the fire. In particular, immediately close supply valves in fuel oil, lube oil, and JP-5 lines.

THE REMOVAL OF HEAT

The fire will go out if you can remove enough heat by cooling the fuel to a temperature below that at which it will support combustion.

Heat may be transferred in three ways: by radiation, by conduction, and by convection. In the process known as radiation, heat is radiated in all directions. Radiated heat is what causes you to feel hot when you stand near an open fire. In conduction, heat is transferred through a substance or from one substance to another by direct contact from molecule to molecule. Therefore, a thick steel bulkhead with a fire on one side can conduct heat from the fire and transfer the heat to the adjoining compartments. In convection, the air and gases rising from a fire are heated. These gases can then transfer the heat to other combustible materials that are within reach. Heat transferred by convection is a particular danger in ventilation systems. These systems may carry the heated gases from the fire to another location several compartments away. If there are combustibles with a low flash point within a compartment served by the same ventilation system, a new fire may start.

To eliminate the heat side of the fire triangle, cool the fire by applying something that will absorb the heat. Although several agents serve this purpose, water is the most commonly used cooling agent. Water may be applied in the form of a solid stream, as a fog, or used together with AFFF.

THE CONTROL OF OXYGEN

Oxygen is the third component of the fire triangle. Oxygen is difficult to control because you obviously cannot remove the oxygen from the atmosphere that normally surrounds a fire. However, oxygen can be diluted or displaced by other substances that are noncombustible.

If a fire occurs in a closed space, it can be extinguished by diluting the air with carbon dioxide (CO_2) gas. This dilution must proceed to a certain point before the flames are extinguished. To reach this point, all ventilation systems to the space must be secured. Once this point has been reached, no fire can exist. In general, a large enough volume of CO_2 must be used to reduce the oxygen content to 15 percent or less.

AFFF foam will also keep oxygen from reaching the burning materials thus smothering the fire.

THE REDUCTION OF THE RATE OF COMBUSTION

Dry chemical fire extinguishing agents and Halon 1301 do not extinguish fires by cooling or smothering. Instead, they are believed to interrupt the chemical reaction of the fuel and oxygen. This reduces the rate of combustion, and the fire is extinguished quickly.

THE IMPORTANCE OF SPEED IN FIRE FIGHTING

Speed is very important in fire fighting. If you allow a fire to burn without confining or extinguishing it, the fire can spread rapidly. A small fire in a trash can may spread to other combustibles and become a large fire that could affect several compartments or even the whole ship. The cost of damage that may have originally been a few dollars could end up costing millions of dollars. Therefore, the ship's fire party must get to the scene with their equipment and start fighting the fire as soon as possible. Any delay that allows the fire to spread will make it more difficult to extinguish the fire with the personnel and equipment available.

EXTINGUISHING AGENTS

The agents commonly used by Navy fire fighters include water, AFFF, dry chemicals, carbon dioxide (CO_2), and Halon 1301. The agent or agents that you will use in any particular case will depend upon the classification of the fire and the general circumstances.

WATER

Cooling is the most common method of fire extinguishment, and water is the most effective cooling agent. Fortunately, water is available in large quantities. Of all the extinguishing agents being used by the Navy, water has the greatest capacity for heat absorption. Therefore, you can cool most burning substances below their ignition points by the application of water.

Aboard ship you will normally apply water to the fire by the use of an all-purpose nozzle. We will discuss the all-purpose nozzle in more detail in chapter 5 of this training manual. The all-purpose nozzle allows you to apply water to the fire as a solid stream, as high velocity water fog, or as low velocity water fog. When you need to reach a fire that is some distance away, or when you need penetrating power, you should use the solid stream. However, water fog is preferred over a solid stream in most cases. A given amount of water in the fog will absorb more heat than the same amount of water in a solid stream. The total amount of water that must be pumped into the ship to fight a given fire will also be reduced when using the fog. All water used for fire fighting must be pumped overboard or otherwise disposed of; this is a definite advantage of using the fog form. In addition to cooling the fire, fog tends to smother the fire by displacing the oxygen.

Because of the cooling capacity of the finely divided water particles, fog can be used successfully on class B fires as well as on class A fires. If you use fog on a class B fire, you need to remember that a danger of a reflash exists until you cool the entire surface of the fuel down below the flash point.

Water is not recommended as an extinguishing agent for electrical fires except as a last resort. When water is properly broken up into a fine spray or fog by the nozzles operating at the designed pressure, the fog does not conduct electric current. But if you shift to a solid stream, or if you accidentally touch the nozzle or the applicator to the electrical equipment, the danger of electrical shock is great. Sometimes it may be necessary to use water fog to fight an electrical fire. In these cases, do not advance the nozzle any nearer to the power source than is absolutely necessary for proper use of the fog pattern.

Water fog gives you considerable protection by forming a screen of water droplets between you and the fire. This fog screen protects you against the intense heat of the fire. This gives you a certain amount of maneuverability in attacking the fire. Water fog also tends to dilute or absorb various vapors and to wash fumes and smoke from the atmosphere. You can help clear smoke from the area by occasionally directing the fog pattern upward for a few seconds.

Before you enter a burning compartment, reduce the heat and flame by a liberal application of water fog. Place the fog into the compartment through doors and other accesses. In the early stages of a large fire, a good deal of the fog applied will turn into steam. The steam will help to smother the fire. You must remember to stand clear of openings, since there is likely to be a violent outward rush of hot gases that are displaced by the steam.

FOAM

Foam is a highly effective extinguishing agent for smothering large fires, particularly those in oil, gasoline, and jet fuels.

AFFF, also known as "light water," is a synthetic, film-forming foam designed for use in shipboard fire fighting systems. The foam proportioning/injection equipment generates a white foam blanket. AFFF proportioning equipment will be discussed in chapter 5 of this training manual. AFFF is equivalent to seawater when it is used to extinguish class A fires.

The unique action of AFFF stems from its ability to make a light-water film float on flammable fuels. As foam is applied over the flammable liquid surface, an aqueous solution drains from the foam bubbles and floats out over the surface to provide a vapor seal. This aqueous film-forming action enhances extinguishment and prevents reflash, even when the foam blanket is disturbed. Fuels which have not been ignited may also be protected with this same action.

AFFF can be used alone or in combination with Purple-K-Powder (PKP), which will be discussed in the next section.

DRY CHEMICALS

Dry chemical powders extinguish a fire by a rather complicated chemical mechanism. They do not smother the fire and they do not cool it. Instead, they interrupt the chemical reaction, known as fire, by suspending fine particles in the fire. In effect, the dry chemicals put a temporary screen between the heat, oxygen, and fuel and maintain this screen just long enough for the fire to be extinguished.

Several types of dry chemicals have been used as fire extinguishing agents. For Navy use, the most important agent of this kind at present is potassium bicarbonate, also known as Purple-K-Powder or PKP. PKP is used to extinguish class B and class C fires because it is very effective against these fires. However, it is both corrosive and abrasive and should be used on class C fires only in emergencies. PKP is primarily used in portable 18-pound extinguishers. However, 9- and 27-pound portable extinguishers are also available for portable use. PKP can be used in conjunction with AFFF. Portable PKP extinguishers and the special equipment for using PKP and AFFF together are described in chapter 5 of this training manual.

CARBON DIOXIDE

Carbon dioxide (CO_2) is an effective agent for extinguishing fires by smothering them. That is, CO_2 reduces the amount of oxygen available for combustion. This smothering action is temporary. You must remember that the fire can quickly rekindle if oxygen is again admitted to hot embers.

CO_2 is a dry, noncorrosive gas that is inert when in contact with most substances. It is heavier than air and remains close to the surface. CO_2 does not damage machinery or other equipment. Since it is a nonconductor of electricity, CO_2 can safely be used to fight fires that might present electric shock hazards. However, the frost that collects on the horn of a CO_2 extinguisher does conduct electricity. Therefore, you should be careful and never allow the horn to come into contact with electrical components.

Aboard ship, CO_2 fire extinguishing equipment includes 15-pound CO_2 extinguishers, 50-pound CO_2 hose and reel installations, and 50-pound CO_2 installed flooding systems.

Although CO_2 is nonpoisonous, it is dangerous because it does not provide a suitable atmosphere for breathing. Asphyxiation can result from breathing CO_2. OBA's must be worn when CO_2 is used below decks or in confined spaces.

HALON 1301

Halon 1301 (bromtrifluoromethane) is a relatively new fire extinguishing agent used in the Navy. Halon 1301 is a colorless, odorless gas with a density approximately five times that of air. It does not conduct electricity or leave a residue. Halon 1301 is stored in compressed gas cylinders for shipboard use.

This extinguishing agent is effective against class A, class B, and class C fires. The fires are not extinguished by smothering or cooling. The chemical reaction of fire is interrupted, as is the case of using PKP. Halon 1301 decomposes upon contact with flames that are approximately 900 °F (482 °C). For Halon 1301 to function effectively as an extinguishing agent, it must decompose. However, as it decomposes, several other products such as hydrogen fluoride (HF) and hydrogen bromide (HBr) are formed. Both gases are irritating to the eyes, skin, and upper respiratory tract. Chemical burns are also possible.

You should not stay in a space where Halon 1301 has been released unless you are wearing an OBA. However, you can safely be exposed to concentrations of 5 to 7 percent for a period up to 10 minutes. In fact, carbon monoxide along with oxygen depletion, heat, and smoke present a greater danger to you than Halon 1301. Chapter 5 of this training manual will discuss Halon 1301 fire extinguishing systems.

SUMMARY

In this chapter, you were introduced to the fundamentals of fire fighting. We identified the three elements required to have a fire along with the classifications of fires. You should now be aware of the effects of fire and the different types of gases you may encounter while fighting a fire. Remember, no two fires are identical; you will have to determine the best method or extinguishing agent to use when fighting a fire. Safety is to be observed always. *Never* assume a compartment's atmosphere is safe for humans. A deadly gas may be present just waiting for a victim. Do not let the victim be you. The equipment used to test a compartment's atmosphere will be discussed in chapter 6 of this training manual.

CHAPTER 5

FIRE-FIGHTING EQUIPMENT AND SYSTEMS

To fight fires effectively, you must have a thorough knowledge of the fire-fighting equipment and systems. The extinguishing agents used in the Navy are discussed in chapter 4 of this manual. This chapter deals with the equipment and systems that are commonly used aboard naval ships to apply the extinguishing agents to fires. This information is general in nature. It should be supplemented by a careful study of the fire-fighting equipment and systems available on your own ship. You will find the manufacturers' technical manuals for the systems and equipment on your ship a source of valuable information.

FIREMAIN SYSTEMS

The firemain system receives water pumped from the sea. It distributes this water to fireplugs, sprinkling systems, flushing systems, machinery-cooling-water systems, washdown systems, and other systems as required. The firemain system is used primarily to supply the fireplug and the sprinkling systems; the other uses of the system are secondary.

Naval ships have three basic types of firemain systems: the single-main system, the horizontal-loop system, and the vertical-loop system. The type of firemain system in any particular ship depends upon the characteristics and functions of the ship. Small ships generally have straight-line, single-main systems. Large ships usually have one of the loop systems or a composite system, which is some combination or variation of the following three basic types.

- The single-main firemain system consists of one main that extends fore and aft. The main is generally installed near the centerline of the ship, extending forward and aft as far as necessary.

- The horizontal-loop firemain system consists of two single fore-and-aft, cross-connected mains. The two mains are installed in the same horizontal plane but are separated athwartships as far as practical.

- The vertical-loop firemain system consists of two single fore-and-aft, cross-connected mains. The two mains are separated both horizontally and vertically. As a rule, the lower main is located below the lowest complete watertight deck, and the upper main is located below the highest complete watertight deck.

- A composite firemain system consists of two mains installed on the damage control deck and separated athwartships. A bypass main is installed at the lower level near the centerline. Cross connections are installed alternately between one service main and the bypass main.

EMERGENCY REPAIRS TO THE FIREMAIN

Firemain systems are designed so that damage to one section does not necessarily affect the operation of the entire system. Fire pumps and cutout valves are installed throughout the system so that a damaged section can be isolated. Isolating a damaged section allows firemain pressure to be maintained in the remainder of the system.

However, a section of firemain piping could be ruptured as in view A of figure 5-1. If that happens, the cutout valves on each side of the break can be closed to isolate the break. The ruptured section can then be removed. Service can be temporarily restored by inserting hose adapters and connecting a length of hose between the adapters (view B of fig. 5-1). Hose flange adapters are provided to repair parties so temporary connections or jumper lines can be rigged. These

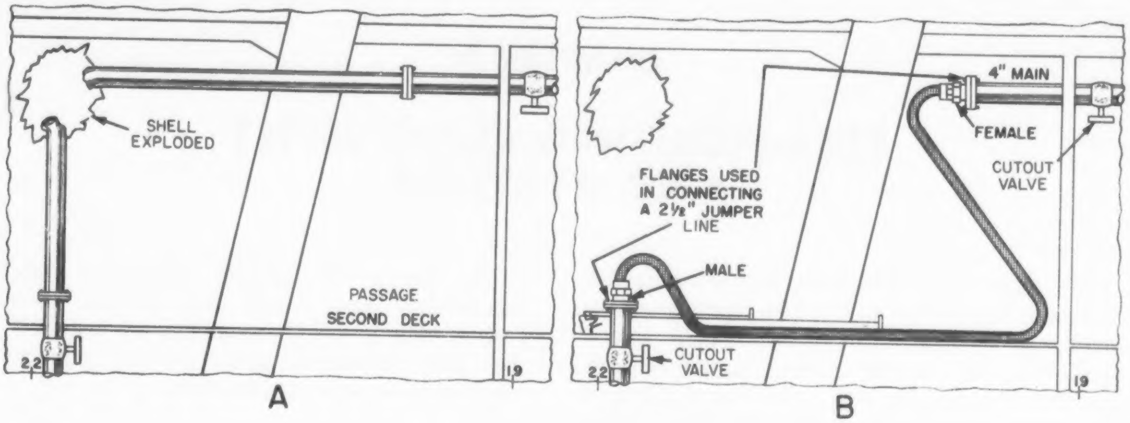

SHELL EXPLODED
PASSAGE
SECOND DECK
22
19
A
4" MAIN
FEMALE
CUTOUT VALVE
FLANGES USED IN CONNECTING A 2½" JUMPER LINE
MALE
CUTOUT VALVE
22
19
B

Figure 5-1.—Providing temporary firemain service by using flanges and fire hose.

8.86

hose flange adapters can be bolted (or clamped with C-clamps) into place quickly and easily.

If the ruptured section of piping cannot be removed, you can provide temporary service by joining together the fireplugs that are nearest the closed cutout valves on each side of the break. In this case, you would use hose and a double female coupling, as shown in figure 5-2. Then open both fireplugs to restore the pressure. This method of emergency repair is effective, but it does eliminate the availability of two fireplugs.

No matter which method of emergency repair you use, repair the damaged section of firemain as quickly as possible.

TESTS AND INSPECTIONS OF THE FIREMAIN SYSTEM

Various tests and inspections for the firemain system are prescribed by the 3-M Systems. These tests and inspections are conducted on the firemain piping, fireplugs, valves, operating gear, remote control operating equipment, and other components.

You will need to flush the firemain system on a quarterly basis. However, if the ship is operating in tropical waters, you must flush the firemain system more often. By flushing the firemain, you help to minimize problems such as fouling of valves. When flushing the firemain, use freshwater whenever possible. Freshwater will help to destroy

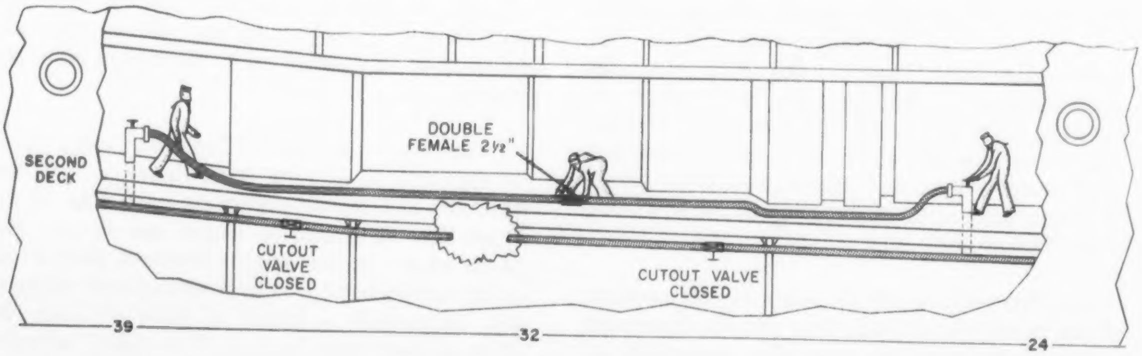

SECOND DECK
DOUBLE FEMALE 2½"
CUTOUT VALVE CLOSED
CUTOUT VALVE CLOSED
39
32
24

Figure 5-2.—Providing temporary firemain service by using hose and double female coupling.

8.85

marine growths within the firemain system. Use a minimum pressure of 60 psi to flush the firemain.

FIRE STATIONS

The numerous fireplugs aboard ship are served by branches from the firemain system. Fireplugs have outlets either 2 1/2 or 1 1/2 inches in diameter.

On small ships, fireplugs are located so that any point on the ship can be reached with 50 feet of fire hose from each of two or more fireplugs. On large ships, any point can be reached with 100 feet of fire hose from each of two or more fireplugs. On aircraft carriers, any area of the flight deck can be reached with 150 feet of hose from at least two fireplugs.

Fireplugs below the weather decks are normally set 5 to 6 feet above the deck. The outlets face downward. If these outlets are 2 1/2 inches in diameter, they are reduced by wye-gates to two 1 1/2-inch outlets. Fireplugs on the weather decks are normally set 13 to 18 inches above the deck with the outlet in the horizontal position.

A quick-cleaning strainer is normally attached directly to each fireplug outlet, as shown at the top of figure 5-3. Sometimes the strainer is attached to a short length of hose. The other end of the hose will connect to the fireplug outlet. This type of installation is shown at the bottom of figure 5-3. It is used only when it is not practical to install the strainer as a direct attachment to the fireplug outlet. Clean out the quick-cleaning strainer by turning the handle as far as it will go. This will discharge the contents of the strainer onto the deck. After the contents have been discharged, place the handle back in its original position. The strainer serves a very important purpose—it allows for rapid removal of marine growths, scales, incrustations, and other foreign matter that could clog the nozzles or nozzle tips.

FIRE HOSE AND FITTINGS

The standard fire hose used by the Navy in the past was a double-jacketed, rubber-lined, cotton hose. Now, when you order either the 1 1/2-inch or the 2 1/2-inch fire hose, you will receive an orange polypropylene-jacketed, rubber-lined hose. The orange hoses will phase out the older hoses. The standard length for both the 1 1/2-inch and the 2 1/2-inch fire hoses is 50 feet. A 50-foot length of hose is normally referred to as a length; longer runs are described in terms of how many lengths they contain. Thus, a 100-foot run of hose is described as two lengths, and a 200-foot run of hose is described as four lengths, and so on.

There are two fittings on each standard length of hose—a male fitting at one end and a female fitting at the other end. Double female couplings are available to connect two male fittings. You will use a double female coupling when you make up a jumper line assembly to bypass a damaged section of firemain. Double male couplings can be used to join two female fittings. Reducer couplings are used to connect the female end of a 2 1/2-inch hose to a 1 1/2-inch outlet.

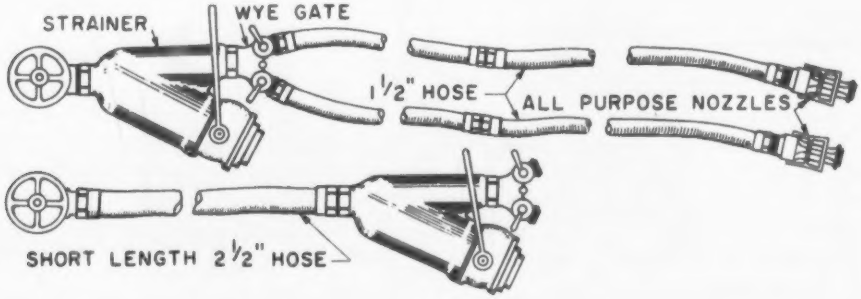
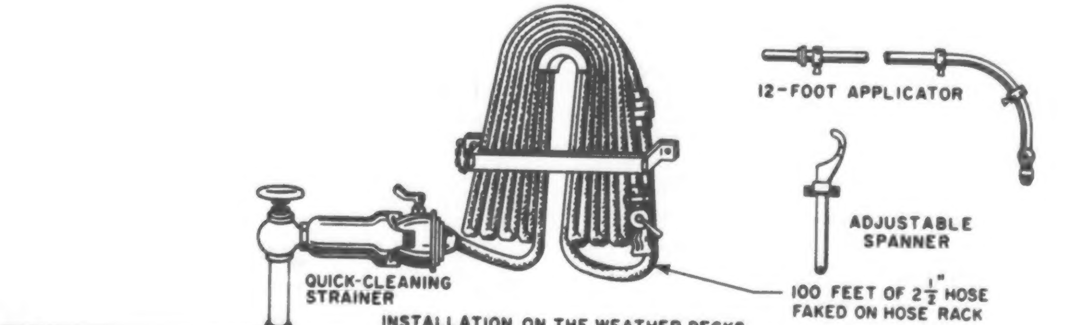


Figure 5-3.—Normal method of connecting quick-cleaning strainer to fireplug outlet (top view) and special method for unusual or inaccessible locations (bottom view).

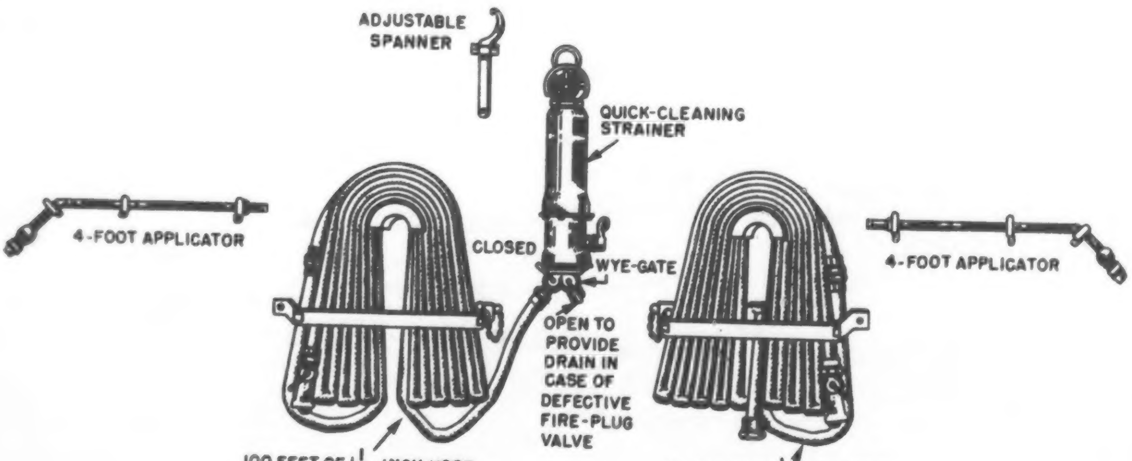
Hoses should be handled and stowed with care. Figure 5-4 shows properly rigged hoses at a fire station. When you roll up a hose, ensure that the male fitting is on the inside of the roll. This method will protect the threads on the male fitting.

After a cotton-jacketed fire hose has been used, it should be thoroughly drained and properly dried. If the hose is not drained properly, a weak solution of sulfuric acid may form inside the hose. The sulfuric acid is produced by a reaction between the water and the sulfur contained in the rubber lining of the hose. It can deteriorate the fire hose. Check the fire hoses weekly, in accordance with PMS, to be sure that they contain no moisture. Once a month, in accordance with PMS, remove the hoses from the racks and restow them. This ensures that the folds in the hoses are not in the same place all of the time.

At least once a year, in accordance with PMS, hydrostatically test the fire hoses to 250 psi for 5 minutes. If you suspect a hose of being damaged or deteriorated, conduct a hydrostatic test on it even if it has not been a year since the last test. The test date must be stenciled on the hose after it has been tested. To stencil the hose, use black paint, MIL-P-2856, on the double-jacketed, rubber-lined, cotton hoses. Use yellow paint, TT-E-489, class A, to stencil the orange, synthetic


12-FOOT APPLICATOR
ADJUSTABLE SPANNER
QUICK-CLEANING STRAINER
100 FEET OF 2½" HOSE FAKED ON HOSE RACK

INSTALLATION ON THE WEATHER DECKS


ADJUSTABLE SPANNER
QUICK-CLEANING STRAINER
4-FOOT APPLICATOR
CLOSED
WYE-GATE
4-FOOT APPLICATOR
OPEN TO PROVIDE DRAIN IN CASE OF DEFECTIVE FIRE-PLUG VALVE
100 FEET OF 1½ INCH HOSE
100 FEET OF 1½ INCH HOSE

3.148

Figure 5-4.—Fire hose properly rigged at fire stations.

rubber hoses. Conduct the hydrostatic test only in such a manner that the ship is not left without fire protection. You may test a third of the hoses at a time. You can do this by removing the hoses from every third fire station on each side to test them. Make sure that no two of the fire stations selected are directly across from each other. You might prefer to conduct the test when your ship is alongside a tender or during a shipyard availability. These two activities can provide your ship with fire protection while you test all of your hoses.

In general, low pressure can be attributed to friction losses through the hose, excessive head pressure, overtaxing of the firemain system, or clogging by foreign matter. Also, such things as breaks in the line, kinks in the fire hose, or partially closed fireplug valves can seriously decrease the pressure available at the nozzle. Be alert for low pressure and know how to locate the cause and correct it.

The pressure delivered at the nozzle is always lower than the pressure at the fireplug because of friction losses. The amount of friction loss depends upon a number of factors. These include the length of the hose; the diameter of the hose; the number, size, and design of the fittings; and the velocity of the stream of water. Because friction loss depends upon so many different factors, it is quite complex to calculate. However, you will learn through experience how friction loss varies with different sizes and lengths of hose.

Excessive head pressure can cause low pressure at the nozzle when water must be forced up through risers. This pressure loss also occurs whenever the nozzle is at a higher level than the plug to which it is connected. There is a decrease of 0.433 psi per foot of elevation. Simple arithmetic indicates that a rise of 20 feet will decrease the pressure by about 8.7 psi.

Overtaxing the firemain can cause low pressure at the nozzles. If too many hoses are in use at the same time, the pressure will drop in all hoses. The only remedy for this is to secure some of the hoses in order to maintain pressure in the most vital ones. A few properly charged hoses are more effective than many undercharged hoses.

If the hose is clogged with foreign matter, pressure will drop. Fortunately, you can quickly correct this trouble by flushing the quick-cleaning strainer at the fireplug.

NOZZLES AND APPLICATORS

The Navy all-purpose nozzle, shown in figure 5-5, comes in two standard sizes: 2 1/2 inches and 1 1/2 inches. The valve on the nozzle can be set in one of three positions—SHUT, FOG, or OPEN.

Fog is generated either by a low-velocity fog head or by a high-velocity nozzle tip. A number of small outlets are drilled at converging angles in the head or tip. The water stream is broken up into fog particles when the small streams impinge upon each other. The size, design, and placement of the outlets determine the velocity with which the fog particles emerge from the nozzle. Control of this velocity is important, since low-velocity fog is better for some fires and high-velocity fog is better for others.

If you want high-velocity fog, leave the high-velocity nozzle tip in place in the fog outlet on the nozzle. If you want low-velocity fog, remove the tip and place an applicator equipped with a low-velocity fog head in the fog outlet on the nozzle. A bayonet joint holds the high-velocity tip or the applicator in the nozzle. The high-velocity tip is permanently attached to the nozzle with a short piece of chain. Thus, the tip is always readily available.

There are three standard sizes of applicators. The 4-foot and the 10-foot applicators will fit only in the 1 1/2-inch Navy all-purpose nozzle. The 12-foot applicator will fit only in the 2 1/2-inch Navy all-purpose nozzle. The size of pipe used and the angle of bend at the low-velocity fog head

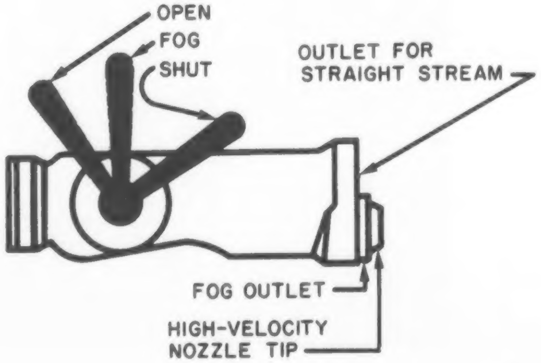


Figure 5-5.—All-purpose nozzle.

for each of the three applicators are shown in figure 5-6.

AFFF SYSTEMS

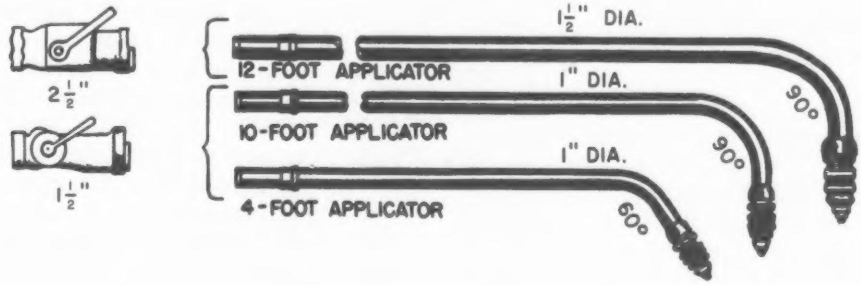
Aqueous film forming foam (AFFF) is one of the most familiar and widely used fire-fighting agents. It is used in conjunction with water or dry chemical to fight class B fires throughout the ship. AFFF is delivered through both portable and installed equipment. You need a basic understanding of the different kinds of AFFF systems and the equipment and components within those systems. Different ships use different AFFF setups. Once you understand these basics, you should be ready to understand and use the AFFF systems aboard any Navy ship.

AFFF GENERATING EQUIPMENT

AFFF generating equipment is located most often in main machinery spaces, JP-5 pump rooms, on flight decks, and in hangars and helo bays. These are the places where class B fires are most common. AFFF is used in both portable and installed generating equipment, both of which are covered in the following pages.

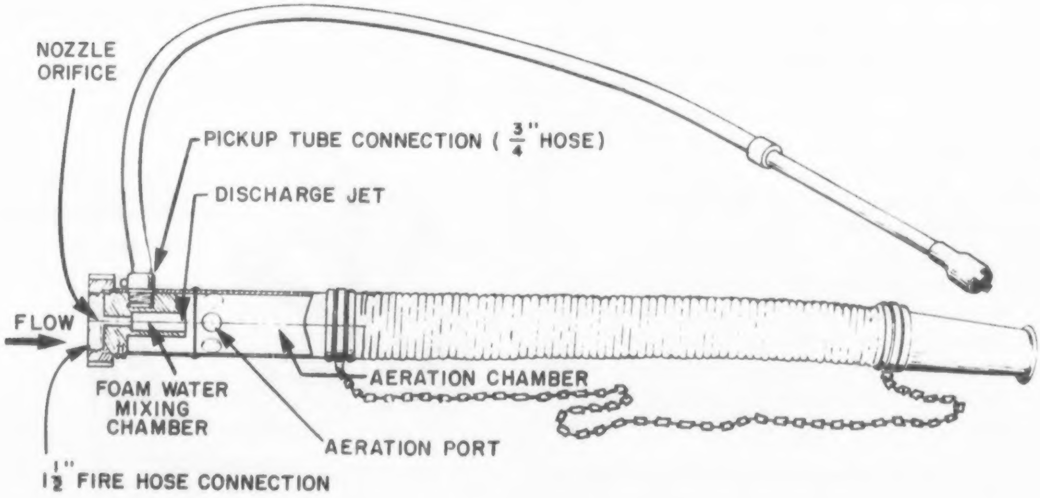
Portable AFFF Equipment

The portable AFFF equipment used to deliver AFFF/water solutions includes the Navy pickup unit (NPU), the FP-180 water motor proportioner, and the in-line inductor. However, both the NPU and the FP-180 units are being


$2\frac{1}{2}$"
$1\frac{1}{2}$"
$1\frac{1}{2}$" DIA.
12-FOOT APPLICATOR
1" DIA.
10-FOOT APPLICATOR
1" DIA.
4-FOOT APPLICATOR
90°
90°
60°

3.151

Figure 5-6.—Standard applicators.


NOZZLE ORIFICE
PICKUP TUBE CONNECTION ($\frac{3}{4}$" HOSE)
DISCHARGE JET
FLOW
FOAM WATER MIXING CHAMBER
AERATION CHAMBER
AERATION PORT
$1\frac{1}{2}$" FIRE HOSE CONNECTION

8.467

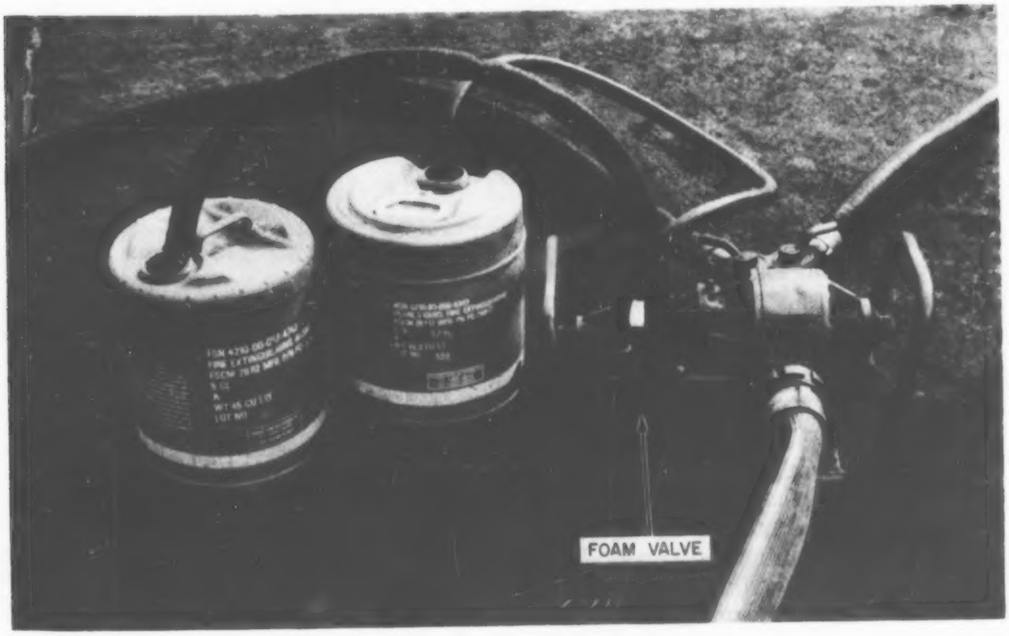
Figure 5-7.—Navy Pickup Unit (NPU) nozzle assembly.

replaced by the in-line inductor in all Navy ships.

NAVY PICKUP UNIT (NPU) NOZZLE.—The NPU nozzle (fig. 5-7) consists of a piece of flexible, wire-reinforced rubber hose with a metal discharge end. A 1 1/2-inch female hose connection is located at the inlet end. This allows the NPU to be connected to a 1 1/2-inch fire hose. A 3/4-inch pickup tube is also connected to the inlet end of the NPU. The pickup tube transfers the AFFF concentrate from 5-gallon containers into the water stream of the NPU nozzle. Four protruding metal tabs are located on the inlet end of the pickup tube. These four tabs are known as a crow's foot. The crow's foot prevents the pickup tube from taking a suction of the AFFF container's bottom. To operate the NPU nozzle, use the following procedures:

1. Connect the inlet end of the nozzle onto a 1 1/2-inch fire hose.
2. Have someone man the NPU nozzle.
3. Open the water supply valve slowly.
4. Insert the pickup tube into a container of AFFF concentrate.
5. When the container is nearly empty, transfer the pickup tube to a full container. A 5-gallon container of AFFF concentrate will only last about 1 1/2 minutes.

WATER MOTOR PROPORTIONER (FP-180).—The FP-180 water motor proportioner (fig. 5-8) consists of a positive displacement water motor that is coupled to a positive displacement rotary gear pump. Inlet and outlet connections for a 2 1/2-inch hose are located on the water motor. There are two connections on the hose selector valve. These are used to connect two 1/2-inch (NPT) AFFF pickup tubes (NPT). The pickup tubes are fitted with a crow's foot. The FP-180 is operated by a water flow that drives the water motor. This causes the direct-connected rotary gear pump to inject a metered amount of AFFF concentrate into the discharge side of the water motor, thus producing the required AFFF/water solution. The rotary gear pump suction is fitted with a hose selector valve with five positions: OFF, PRIME No. 1, HOSE No. 1, PRIME No. 2, and HOSE No. 2. The selector valve allows you to provide the nozzleman with an uninterrupted flow of AFFF/water solution. When the hose selector valve is in the OFF position, only water will be available as a



3.154

Figure 5-8.—FP-180 water motor proportioner.

fire-fighting agent. The FP-180 will proportion AFFF concentrate into the water stream at inlet pressures of 75 to 175 psi, and with flow rates of 60 to 180 gpm. The ideal operating pressure is 125 psig. The general procedure for operating the FP-180 is as follows:

1. Connect the supply and discharge hoses to the water motor. A 2 1/2-inch hose or two 1 1/2-inch hoses connected to the FP-180 with a wye-gate may be used to dispense the AFFF/water solution.

2. Set the hose selector valve handle to the OFF position.

3. Insert each pickup tube into a full container of AFFF concentrate.

4. Station personnel on the discharge hoses.

5. Open the water supply valve slowly.

6. Shift the hose selector valve handle to HOSE No. 1. The valve is designed so a jet of water flows through the pickup tube. This purges the tube of air and ensures immediate priming of the rotary gear pump when the valve is at the intermediate position of PRIME No. 1 or PRIME No. 2.

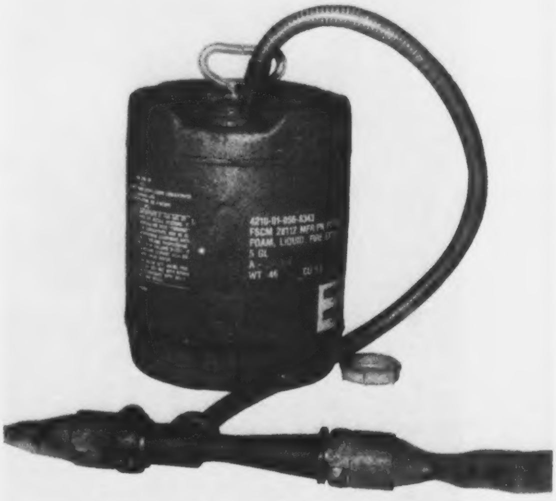
7. When the FP-180 is operating, the level of AFFF concentrate in the container should decrease. If the concentrate level does not decrease within a few seconds, shift the selector valve handle to HOSE No. 2 position and check the first pickup tube for a blockage or an air leak.

8. When the AFFF container is almost empty, shift the selector valve handle to the appropriate position and replace the empty container immediately.

The FP-180 water motor proportioner requires a certain amount of care and maintenance. After draining the unit of water, squirt a few ounces of light lubricating oil into the water motor through the inlet and discharge openings. Also squirt oil into the hose selector valve and the rotary gear pump. To do this, place the selector valve handle on HOSE No. 1 or HOSE No. 2, pour oil into the appropriate pickup tube, and then turn the extended shaft several revolutions with a wrench to distribute the oil within the proportioner. Check the proportioner periodically for free turning. You can do this by removing the crank opening cover and turning the extended shaft with a wrench. Replace the crank opening cover to prevent the oil from leaking out and foreign matter from getting inside.

IN-LINE FOAM INDUCTOR.—The in-line foam inductor (fig. 5-9) is becoming standard equipment on all naval ships. It is replacing the portable FP-180 water motor proportioner and the Navy pickup unit.

The in-line foam inductor is simple in design, operation, and maintenance. It uses a venturi principle to induct AFFF concentrate into a water stream. As water enters the inlet end of the in-line foam inductor, the velocity of the water is increased by the use of a flow restriction. This creates a negative pressure area in the venturi throat. A pickup tube with a ball check valve and a crow's foot is connected to the venturi throat. The ball check valve stops water backflow when the flow is restricted or when the nozzle is shut off. The pickup tube is placed into a container of AFFF concentrate. Atmospheric pressure forces the concentrate up the tube and into the water stream, thus producing the AFFF/water solution. The AFFF nozzle that is used with the in-line foam inductor must have the same gallonage rating as the in-line foam inductor. If you do not match the nozzle and the in-line foam inductor, you will get either poor quality AFFF/water solution or no solution at all. The in-line foam inductor currently used in the Navy is rated at 95 gpm with a 1 1/2-inch hose inlet and discharge connection. The authorized nozzle is a 95-gpm variable-pattern nozzle with a trigger-operated shutoff.



8.468

Figure 5-9.—In-line foam inductor.

The in-line foam inductor has several advantages over the FP-180 and the NPU. First, it is lighter in weight and requires simpler maintenance than the FP-180. The weight factor is significant because it allows you to respond to a fire quickly. The efficiency of the in-line foam inductor does not decrease as much as the efficiency of the FP-180 does with age and wear. In addition, the in-line foam inductor does not have to be relocated when the nozzleman moves, as is the case with the NPU. This allows containers of AFFF concentrate to be left at one location away from the scene of the fire. This reduces confusion and gives the nozzleman a greater freedom of movement.

The in-line foam inductor has few disadvantages. A firemain pressure of 100 psig must be maintained to the in-line foam inductor to produce a good-quality AFFF/water solution. This means that only one length of hose (50 feet) may be used between the in-line foam inductor inlet and the fireplug discharge. You can also connect the in-line foam inductor directly to the fireplug. This limits the maximum length of hose authorized between the in-line foam inductor discharge and the nozzle inlet to 150 feet. Finally, you should not operate the nozzle any higher than one deck above the location of the in-line foam inductor.

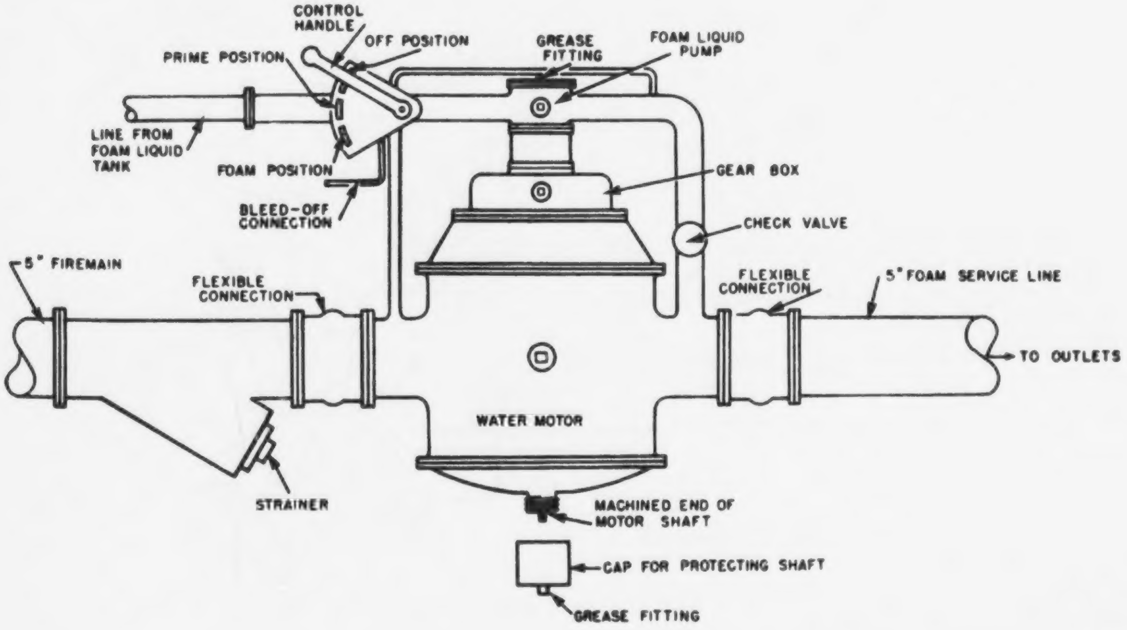
Installed AFFF Equipment

The installed AFFF equipment includes the water motor proportioners, the positive displacement pump, the centrifugal pump, and the balanced-pressure proportioner.

The installed water motor proportioners and the centrifugal pumps are being phased out and replaced with positive displacement pumps or balanced-pressure proportioning systems.

WATER MOTOR PROPORTIONERS.—The two most common installed water motor proportioners are the FP-180 and the FP-1000. The installed FP-180 is a modified portable FP-180. The modifications to the proportioner should conform to NAVSEA drawing number 803-2145520 current revision before the unit is installed. The portable FP-180 was discussed earlier in this chapter.

The FP-1000 water motor proportioner (fig. 5-10) consists of a positive displacement water motor connected to a positive displacement rotary gear pump. The proportioner will give


CONTROL HANDLE
OFF POSITION
PRIME POSITION
GREASE FITTING
FOAM LIQUID PUMP
LINE FROM FOAM LIQUID TANK
FOAM POSITION
GEAR BOX
BLEED-OFF CONNECTION
CHECK VALVE
5" FIREMAIN
FLEXIBLE CONNECTION
FLEXIBLE CONNECTION
5" FOAM SERVICE LINE
TO OUTLETS
WATER MOTOR
STRAINER
MACHINED END OF MOTOR SHAFT
CAP FOR PROTECTING SHAFT
GREASE FITTING

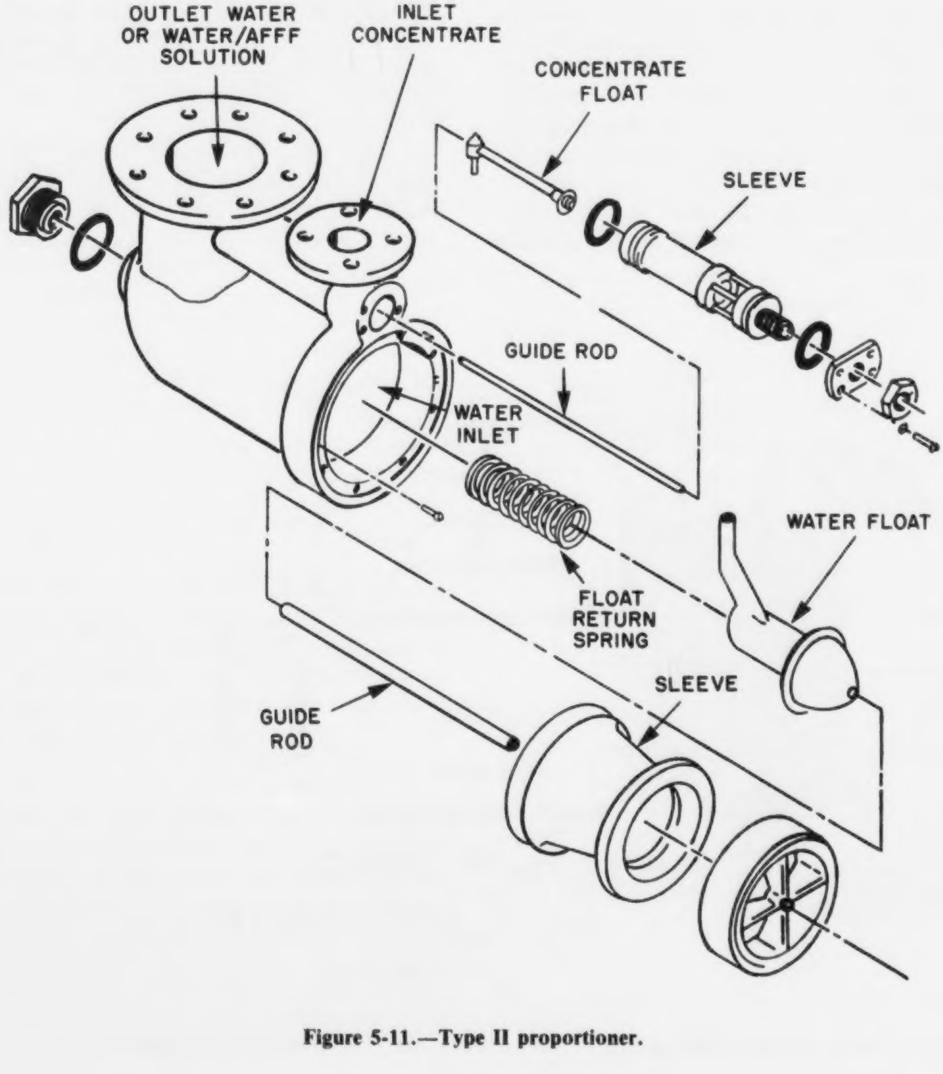
3.157

Figure 5-10.—High-capacity FP-1000 water motor proportioner (viewed from above).

the most accurate proportioning with flows of 200 to 1,000 gpm when the water motor inlet pressure is between 100 and 175 psig.

CENTRIFUGAL PUMPS.—Centrifugal pumps have limited use in AFFF generating systems. Currently only one system, the FP-1000 water motor proportioner, uses the centrifugal pump as a booster pump. The unit consists of a 440-volt, 60-hertz, three-phase motor connected to the pump by a flexible coupling. The maximum pump capacity is 100 gpm with a minimum static head. The higher the static head, the less efficient the centrifugal pump. These pumps do not require a relief valve because of their 100-percent slippage capability.

POSITIVE DISPLACEMENT PUMPS.—Positive displacement pumps installed in AFFF generating systems are a sliding vane and rotary gear type. The pump capacity ranges from 12 to 80 gpm of AFFF concentrate. The unit consists of a 444-volt, 60-hertz, three-phase motor that is connected to the pump by flexible couplings or a belt and pulley assembly. The horsepower rating of the motor will vary with the capacity of the pump used. The unit may be installed as an injection pump or a transfer pump or as a subassembly to supply AFFF concentrate to a



OUTLET WATER OR WATER/AFFF SOLUTION
INLET CONCENTRATE
CONCENTRATE FLOAT
SLEEVE
GUIDE ROD
WATER INLET
WATER FLOAT
FLOAT RETURN SPRING
SLEEVE
GUIDE ROD

8.469

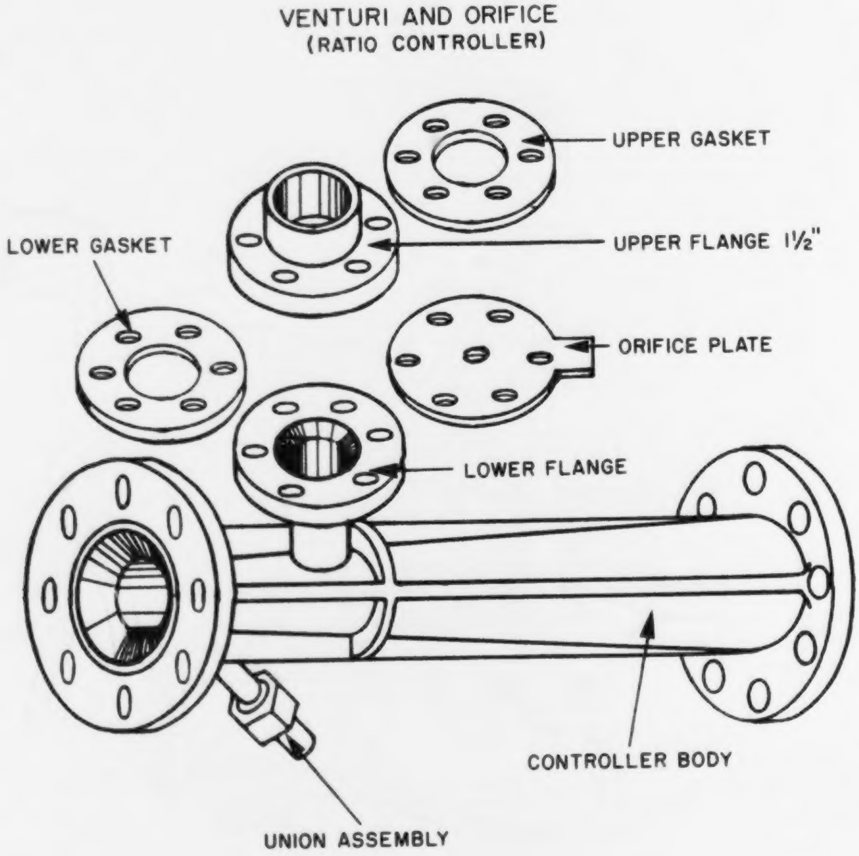
Figure 5-11.—Type II proportioner.

balanced-pressure proportioning system. All positive displacement pumps require a relief valve to prevent excessive pressure buildup and pump damage.

BALANCED-PRESSURE PROPORTIONERS.—Balanced-pressure proportioners are demand type. The proportioner will only proportion the amount of AFFF concentrate necessary to produce a satisfactory AFFF/water solution over a wide range of flows and pressures. Two types of proportioners are currently used in the Navy. The type II and the type III. Both proportioners use the venturi principle to mix AFFF concentrate and water together. The capacities of the type II and the type III proportioners range from 60 to 1,000 gpm of the AFFF/water solution.

The type II proportioner (fig. 5-11) consists of a proportioner body that is flanged for piping connections. The body houses a concentrate sleeve, a concentrate float with a guide rod, a water sleeve, a water float with guide rod, and a water float return spring. The concentrate float is connected to the water float. Any movement of the water float will cause the AFFF float to move proportionately.

The type III proportioner (fig. 5-12) also consists of a proportioner body that is flanged for piping connections. The body is essentially a hollow tube with flow restriction and no moving parts. The amount of AFFF concentrate entering the proportioner is controlled by an orifice plate. The size of the orifice is determined by the total demand placed on the proportioner.



8.470

Figure 5-12.—Type III proportioner.

AFFF System Components

The AFFF system components include the AFFF concentrate tanks, various valves used in the system, and the single agent hose reel.

AFFF CONCENTRATE TANKS.—AFFF concentrate tanks (service or reserve storage) range in capacity from 35 to 3,500 gallons of AFFF concentrate. They are equipped with an externally mounted indicator to show the level of AFFF concentrate in the tank. They are also equipped with access plates for cleaning and inspection. The tanks can be filled quickly from 5-gallon containers, 55-gallon containers, and reserve storage tanks, depending on the type of ship and the AFFF generating system design. Tanks are vented to allow trapped air to escape during filling operations and to relieve any vacuum that occurs as a result of pumping AFFF concentrate out of the tanks. The AFFF concentrate tanks should be fabricated out of 90/10 copper-nickel alloy.

AFFF VALVES.—The AFFF system requires a variety of valves with different capabilities and functions. These valves are described below.

Powertrol Valve.—The powertrol valve (fig. 5-13) is a diaphragm-type, hydraulically operated, globe control valve. It is most commonly used as the AFFF control valve. However, some AFFF generating systems use the valve as a water control and AFFF control valve. The AFFF control valve controls the flow of AFFF concentrate. The valve is fitted with an indicator stem (threaded into the main stem) to indicate whether the valve is open or closed. The cover contains a telltale hole to indicate if the diaphragm is ruptured. The

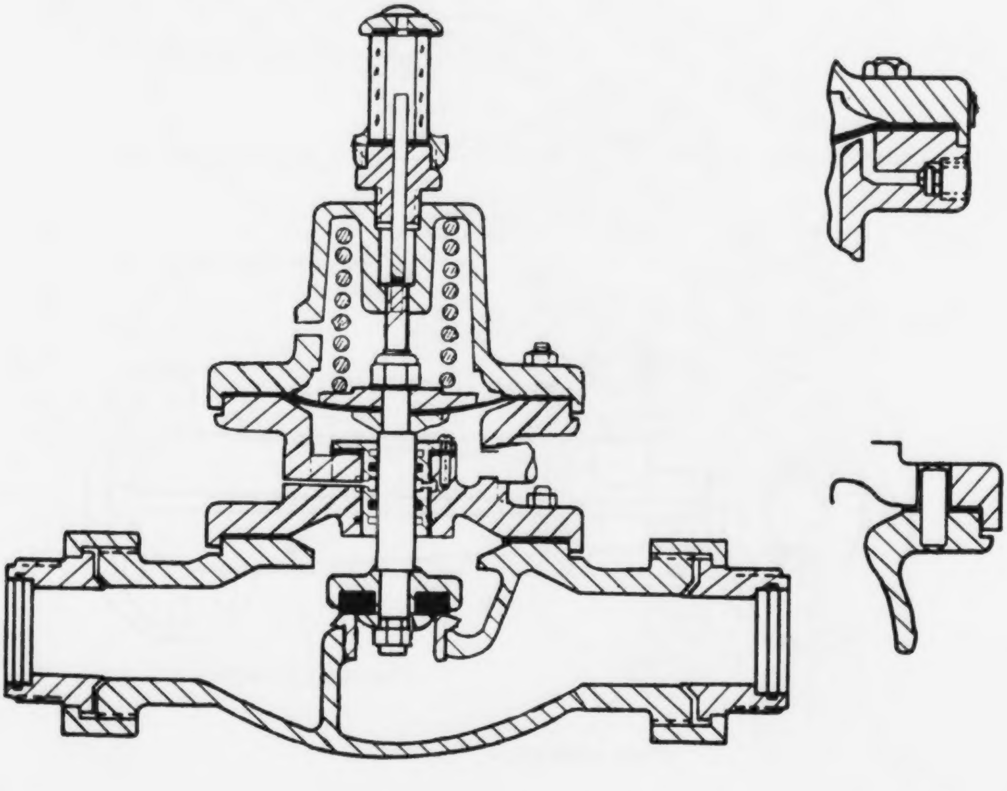
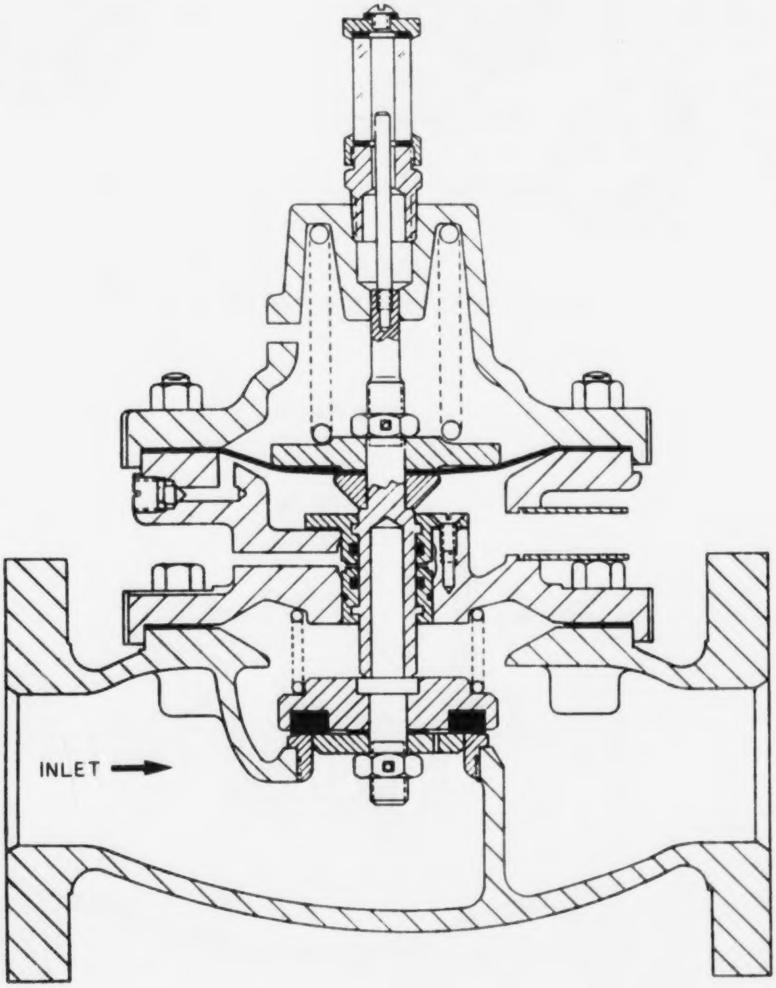

8.471

Figure 5-13.—Powertrol valve.

valve is normally held closed by spring pressure acting on the diaphragm, forcing the stem and disk assembly against the seat, thus stopping the fluid flow. Open the valve by pressurizing the operating chamber with fluid. This fluid acts on the underside of the diaphragm, forcing the stem and disk assembly upward, thus overcoming the spring pressure and allowing the fluid to flow.

Powercheck Valve.—The powercheck valve (fig. 5-14) is a diaphragm-type, hydraulically operated, globe control valve. It is used as an AFFF control valve. The valve is essentially a powertrol valve with check valve features. Powerchecks contain two stems, an upper stem and a lower stem, each of which moves independently of the other. This feature permits flow in one direction only. When flow stops and back pressure develops, the lower stem and disk assembly will be forced downward (lower spring/back pressure) against the seat, stopping the fluid flow. The valve will check even though the operating chamber is pressurized.

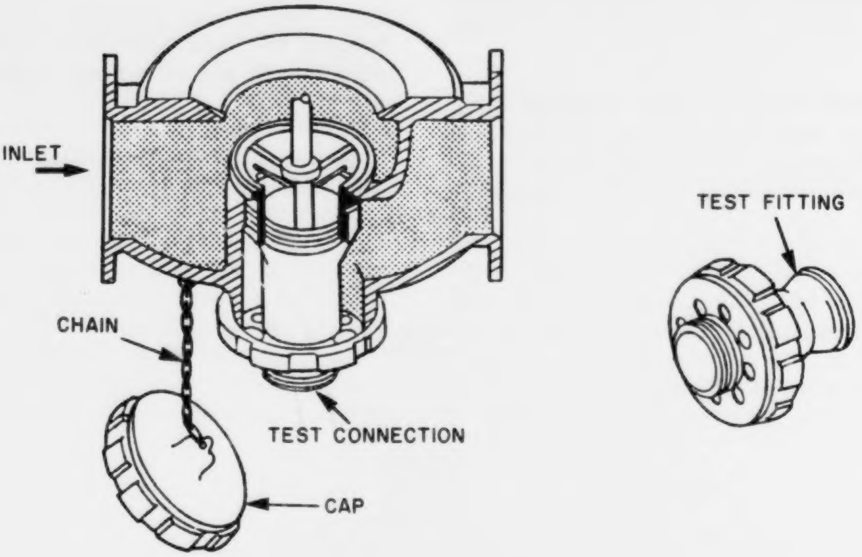
Powertrol Valve with Test Connection.—The powertrol valve with test connection



8.472

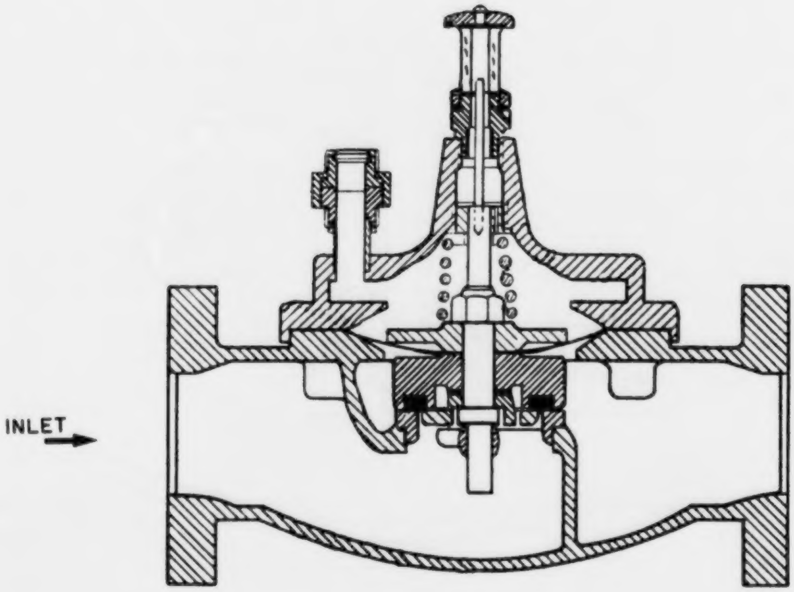
Figure 5-14.—Powercheck valve.

(fig. 5-15) is a diaphragm-type, hydraulically operated, globe control valve. It is essentially a powertrol valve with testing capabilities. This valve is normally used as a sprinkler group control valve. It would be impractical to test a sprinkler group unless the fluid flow could be diverted before it is discharged through the sprinkler heads. To make a test, remove the test connection cap from the bottom of the valve and insert a test fitting. The test fitting has an O ring



8.473

Figure 5-15.—Powertrol valve with test fitting.



8.474

Figure 5-16.—Hytrol valve.

to provide a seal between the fitting and the elongated neck on the valve seat. Connect a drain hose to the fitting and place the outlet end of the hose at a suitable location. When the operating chamber is pressurized, the valve opens. Fluid is routed over the top of the seat, diverted through the test fitting and out the drain hose. The valve is successfully tested and the sprinkler groups are dry. When the test is complete, vent the operating chamber, remove the test fitting, and reinstall the test connection cap.

Hytrol Valve.—The hytrol valve (fig. 5-16) is a diaphragm-type, hydraulically operated, globe control valve. It is most commonly used as a water control valve. The water control valve controls the flow of water into the distribution piping or proportioner. Hytrol valves have an indicator stem threaded into the main stem to show whether the valve is open or closed. To close the valve, pressurize the operating chamber with fluid. The fluid acts on top of the diaphragm, forcing the stem and disk assembly downward against the seat, thus stopping the fluid flow. A spring positioned on top of the diaphragm assists in closing the valve. To open the valve, vent the operating chamber. Fluid pressure at the inlet opening will force the disk assembly upward, thus overcoming the spring pressure and allowing fluid to flow.

Hycheck Valve.—The hycheck valve (fig. 5-17) is a diaphragm-type, hydraulically operated,

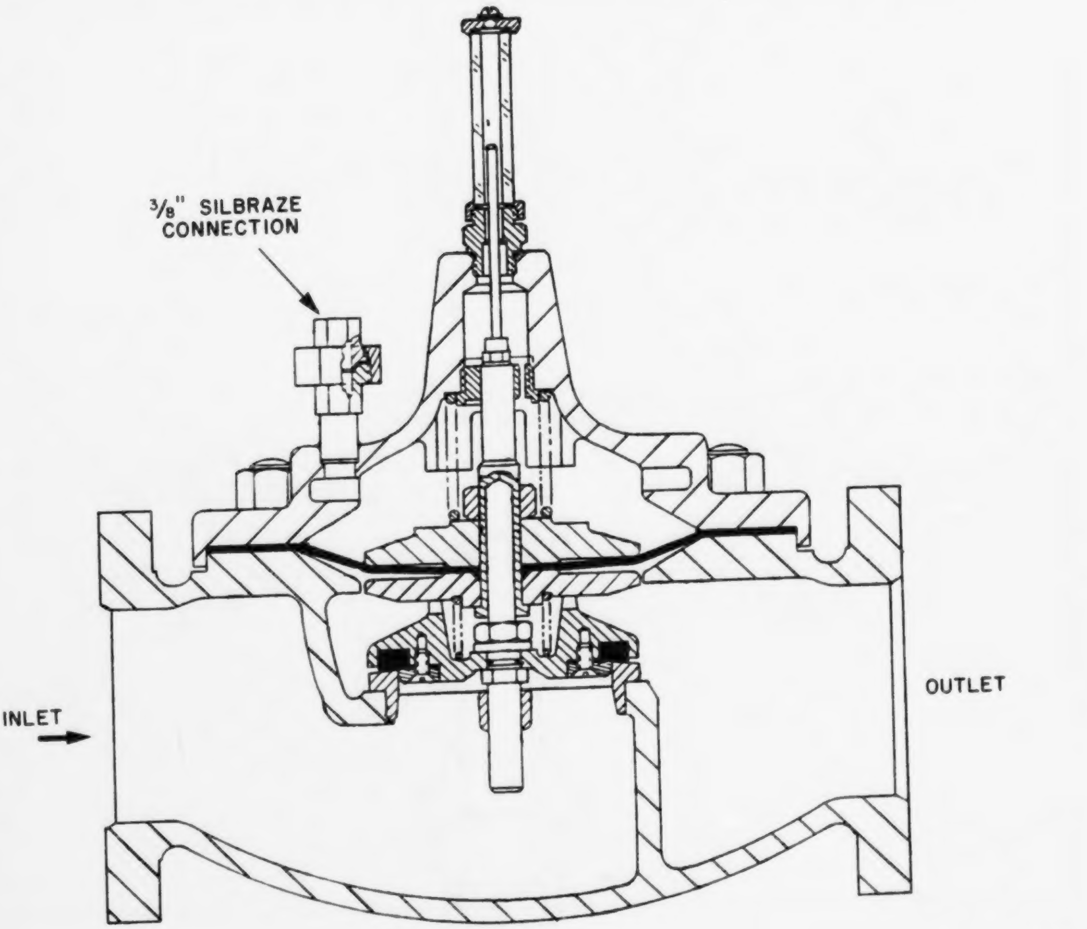


Figure 5-17.—Hycheck valve.

globe control valve. It is used as a water control valve. A hycheck valve is essentially a hytrol valve with check valve features. Hychecks contain two stems, an upper stem and a lower stem, each of which moves independently of the other. This feature permits flow in one direction only. When flow stops and back pressure develops, the lower stem with disk assembly will be forced downward (lower stem spring/back pressure) against the seat, thus stopping the fluid flow.

Hytrol Valve with Test Connection.—The hytrol valve with test connection is a diaphragm-type, hydraulically operated, globe control valve. It is essentially a hytrol valve with testing capabilities. The testing features of the hytrol valve with test connection are identical to those of the powertrol valve with test connection (fig. 5-15). To use the valve, vent the operating chamber and fluid pressure at the inlet opening. This will act on the underside of the diaphragm to force the disk assembly upward, overcome the spring pressure, and allow the fluid to flow. The fluid flow will be routed over the top of the seat, diverted through the test fitting and out the drain hose. When the test is complete, pressurize the operating chamber, remove the test fitting and reinstall the test connection cap.

3-Way Interlock Valve.—The 3-way interlock valve (fig. 5-18) is used in some AFFF generating systems that use a hytrol or hycheck valve as a water control valve. It is used in conjunction with the dry-chemical unit to cause actuation of the AFFF generating system simultaneously with the dry-chemical unit. Some ships use a pressure switch for this purpose. In the open position, the interlock valve will route water out the control

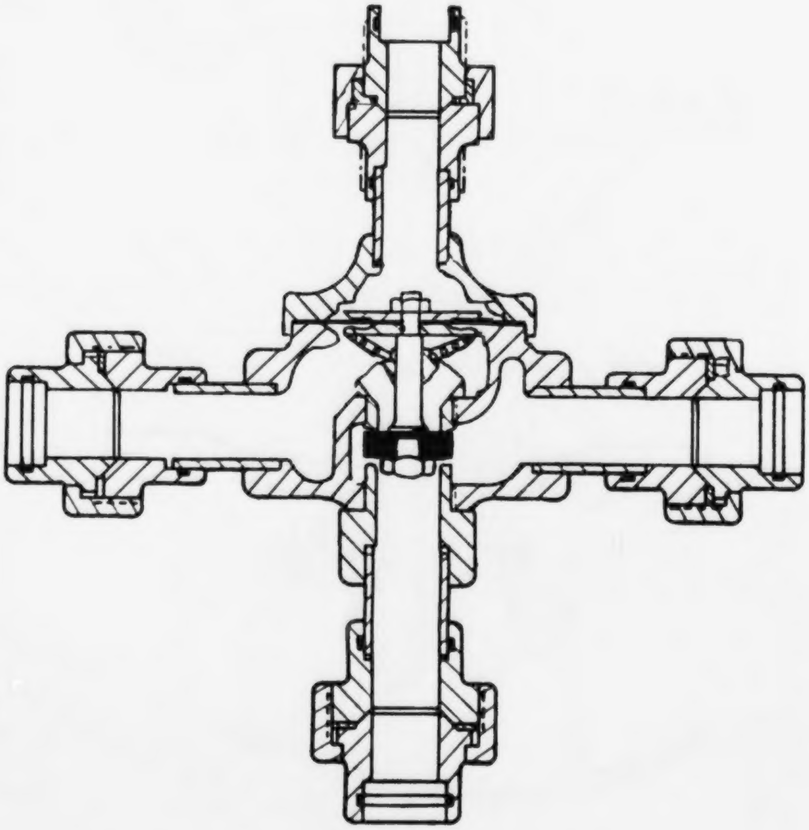
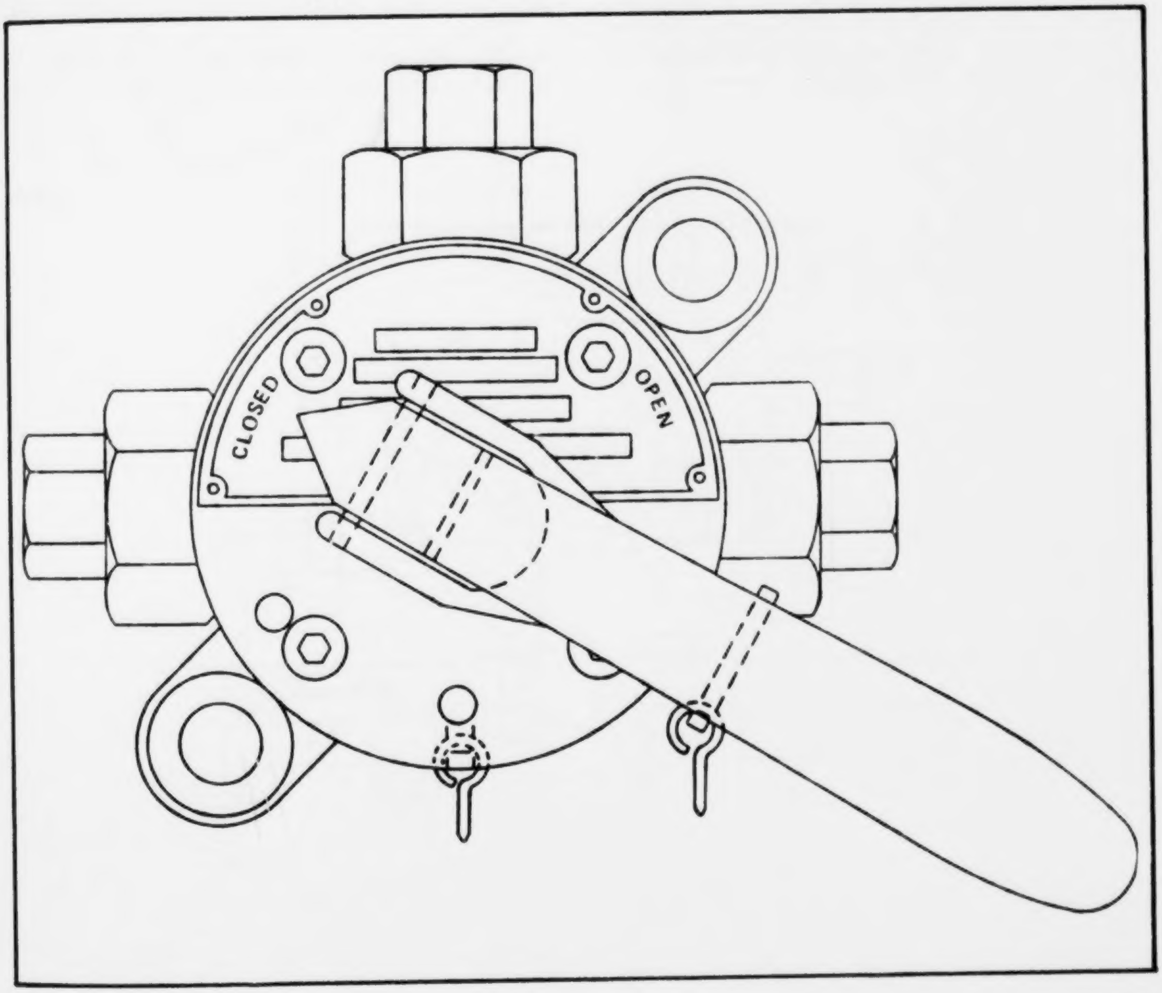

8.476

Figure 5-18.—3-way valve.

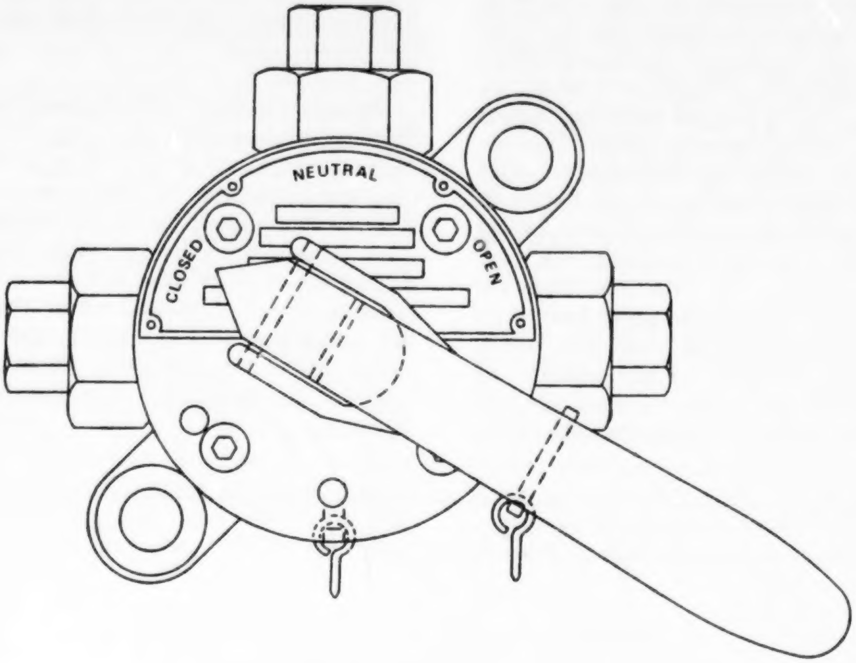
outlet port and ultimately to the operating chamber of the hytrol or hycheck valve. To close the interlock valve, pressurize the operating chamber with nitrogen. Nitrogen acts on top of the diaphragm, forcing the disk assembly against the lower seat, securing the water supply. The control outlet port is aligned with the drain port. This allows the operating chamber of the hytrol or hycheck valve to be vented, which, in turn, allows the valve to open. Opening of the interlock valve is caused by venting the nitrogen from the operating chamber through the green ball valve. A spring acts on the underside of the diaphragm, causing the disk assembly to seat against the upper seat. This action closes off the drain port and allows water to flow through the outlet port. Ultimately, the water flows to the operating chamber of the hytrol or hycheck valve, causing the valve to close.

Manual Control Valve (Closed/Open, Three Port).—This manual control valve (fig. 5-19) is used to actuate the hytrol or hycheck valve. In the closed position, the valve routes the water through the "closed" port and ultimately to the hytrol or hycheck valve operating chamber, thus closing the valve. When the valve is in the open position, water is isolated within the valve and the closed port is aligned with the open port. This vents the operating chamber of the hytrol or hycheck valve, thus causing the valve to open.



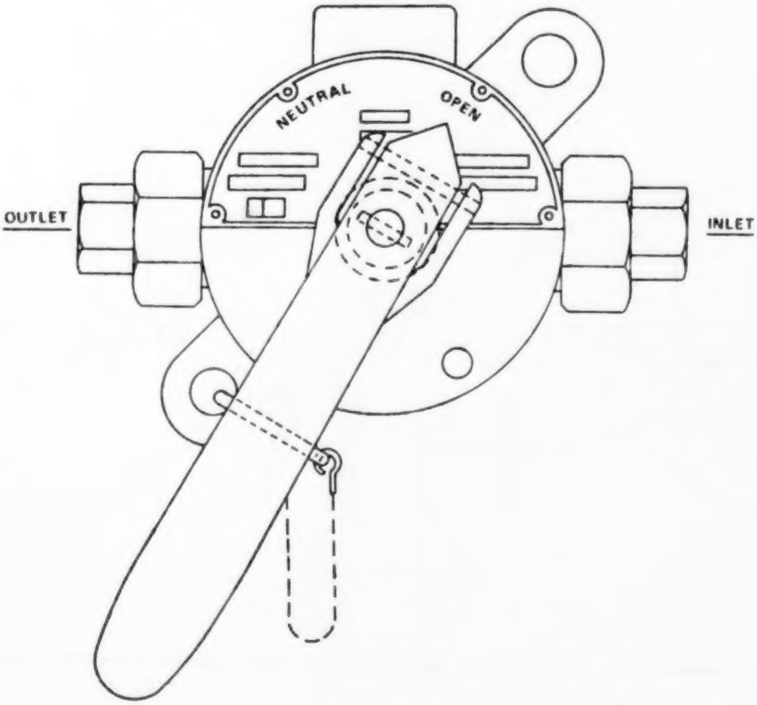
8.477

Figure 5-19.—2-way 3-port manual control valve.


NEUTRAL
CLOSED
OPEN

8.478

Figure 5-20.—3-way 3-port manual control valve.


NEUTRAL
OPEN
OUTLET
INLET

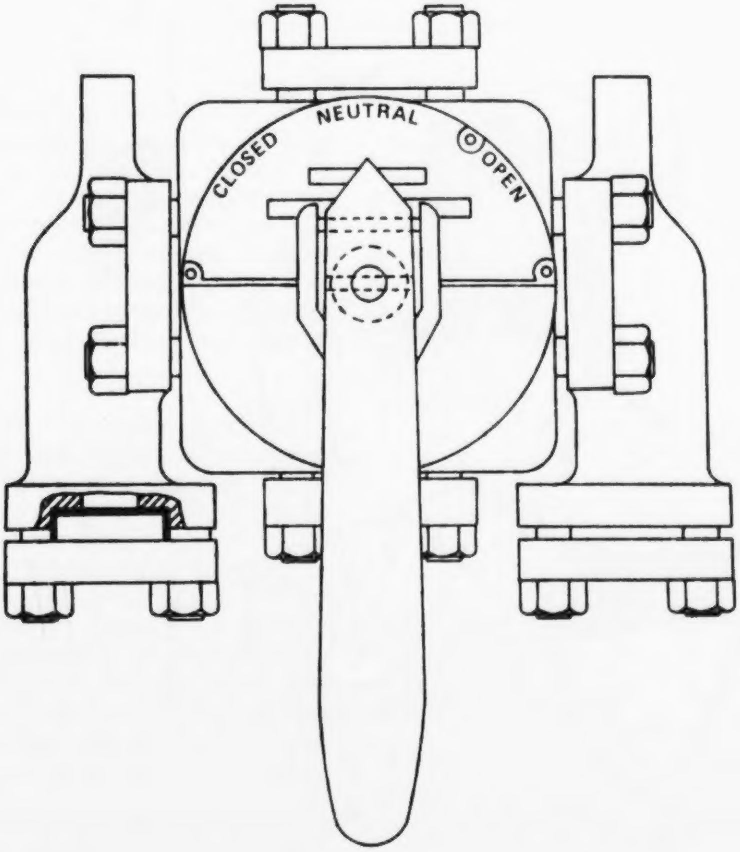
8.479

Figure 5-21.—2-way 2-port manual control valve.

Manual Control Valve (Closed/Neutral/ Open, Three Port).—This manual control valve (fig. 5-20) is used only to actuate powertrol-type valves. When the valve is in the neutral position, water is isolated within the valve. In the open position, the valve routes the water through the open port to pressurize the operating chamber of powertrol-type valves. In the closed position, the valve routes the water through the closed port and to the operating chamber of a 3/8-inch control line powertrol valve, thus causing the valve to open. The control line valve vents the operating chamber of the powertrol-type valve, thus causing the valve to close. To close the control line powertrol valve, set the manual control valve in the neutral position. The operating chamber will vent through an orifice plate that is installed in the control line and eventually close.

Manual Control Valve (Neutral/Open, Two Port).—This manual control valve (fig. 5-21) is used to actuate (open only) powertrol-type valves. It is positioned at remote AFFF/water solution outlets. When the valve is in the neutral position, water is isolated within the valve. In the open position, the valve routes the water through the outlet port, thus pressurizing the operating chamber of powertrol-type valves. This valve is used in conjunction with the closed/neutral/open, three-port manual control valve to reset the powertrol-valves.

Manual Control Valve (Closed/Neutral/ Open, Four Port).—This manual control valve (fig. 5-22) is used to actuate hytrol-type valves that are used in conjunction with bilge sprinkler systems. When the valve is in the neutral position, water is isolated within the valve. When the valve is in the open position, the water is routed through the closed port and the open port is aligned with the drain. With the valve in the closed position, the water is routed



8.480

Figure 5-22.—3-way 4-port manual control valve.

through the open port and the closed port is aligned with the drain.

Solenoid Operated Pilot Valve (SOPV).— SOPVs are electrically or manually operated pilot valves (fig. 5-23) that actuate hytrol- or powertrol-type valves. Coil assemblies (open or closed), when energized via actuation switches, create a magnetic field. This causes a linkage arrangement, which is connected to the stem, to rotate the valve to open or close it. The stem may be manually rotated by a T handle or knob assembly, counterclockwise to open and clockwise to close the valve. A switch assembly is activated when the linkage arrangement moves either by electrical or manual operation. This sends an electrical signal to a motor controller or alarms/indicator lights. When the SOPV is in the closed position, the water is routed through the odd-numbered port(s) and thereby pressurizes the operating chamber of hytrol-type valves. As the water is routed through the odd-numbered port(s),

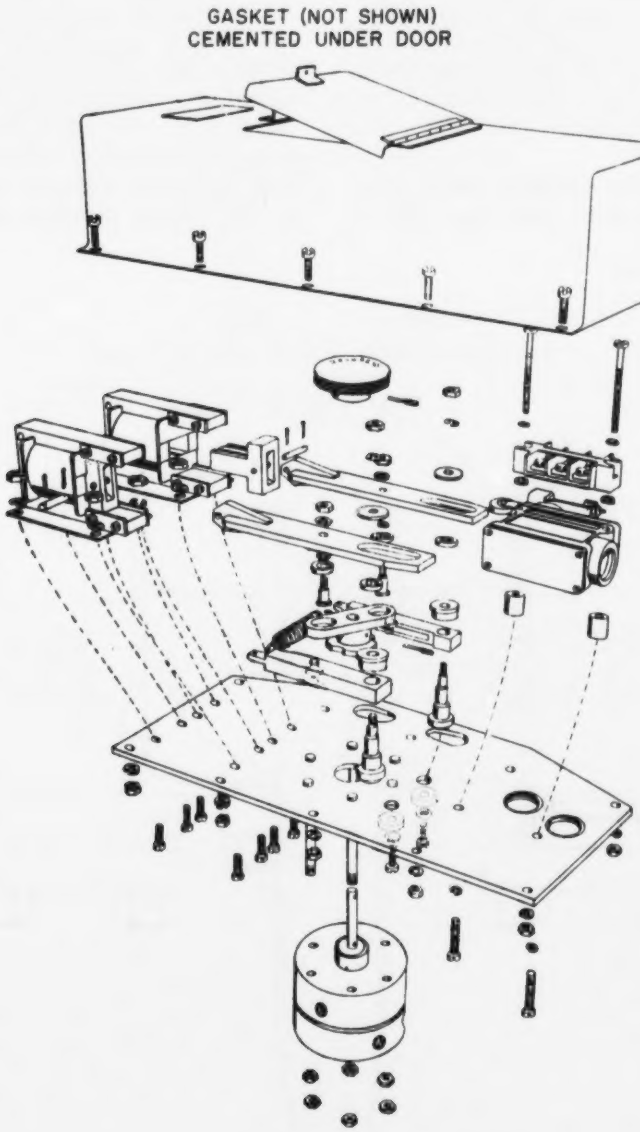
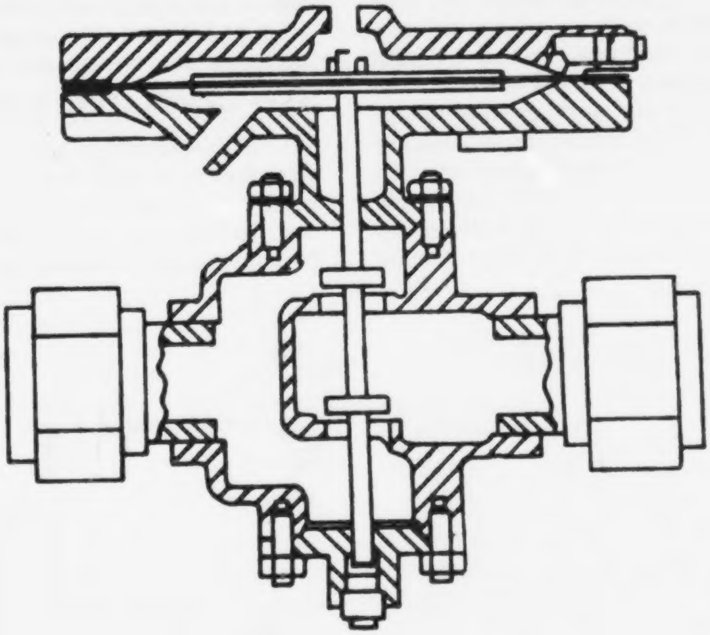


Figure 5-23.—Solenoid operated pilot valve.



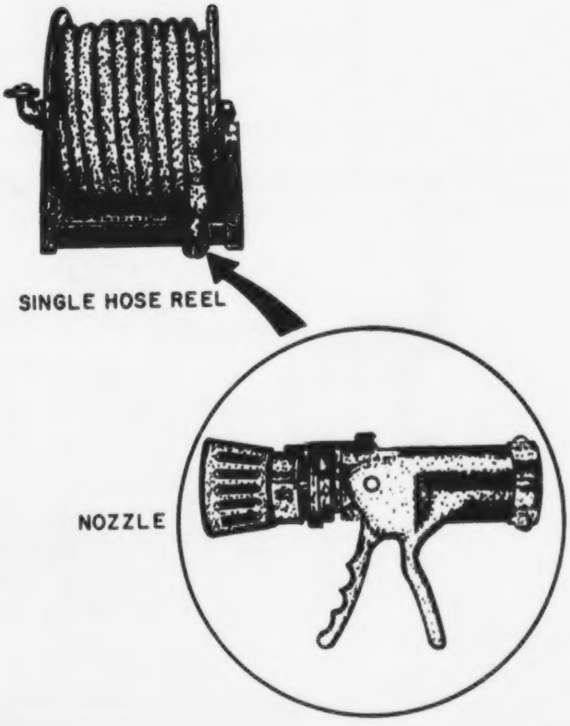
8.482

Figure 5-24.—Balancing valve.

the even-numbered port will be aligned with the drain port, thus venting the operating chamber of the powertrol-type valves. When the SOPV is in the open position, the water is routed through the even-numbered port. This pressurizes the operating chamber of powertrol-type valves to open the valve. The odd-numbered port will be aligned with the drain port to vent the operating chamber of the hytrol-type valves, thus opening the valves.

Balancing Valve.—The balancing valve (fig. 5-24) is a diaphragm-type, hydraulically operated, globe regulating valve. It is installed in the recirculation line of balanced-pressure systems between the concentrate pump discharge and the AFFF service tank. The balancing valve has two operating chambers with sensing lines. The line on top of the diaphragm senses water pressure, and the line on the bottom of the diaphragm senses AFFF concentrate pump pressure. Any fluctuation in water pressure will cause the balancing valve to regulate the AFFF concentrate discharge pressure to equal the water pressure.

SINGLE AGENT HOSE REEL.—The single agent hose reel (fig. 5-25) consists of 125 feet or 150 feet of 1 1/2-inch noncollapsible hose for



8.483

Figure 5-25.—Single agent hose reel.

AFFF/water solution or water alone. The hose reel is installed near accesses to main machinery spaces for reentry purposes, and at aviation facilities such as hangar bays, flight decks, and helo decks; the hose is used as the primary attack fire-fighting hose. There are two types of single agent nozzles. One is rated at 95 gpm, is trigger operated, and is found on all machinery space reentry hoses. The other is rated at 125 gpm, is bail operated, and is found on aviation facility hoses. The nozzles are rated at a constant flow of 95 or 125 gpm with an adjustable fog pattern and a variable-stream nozzle.

AFFF GENERATING SYSTEMS

AFFF generating systems vary throughout the fleet and from one ship to the next. The complexity and variation of the system will depend on the demand for AFFF/water solution on a particular ship. You need a basic understanding of

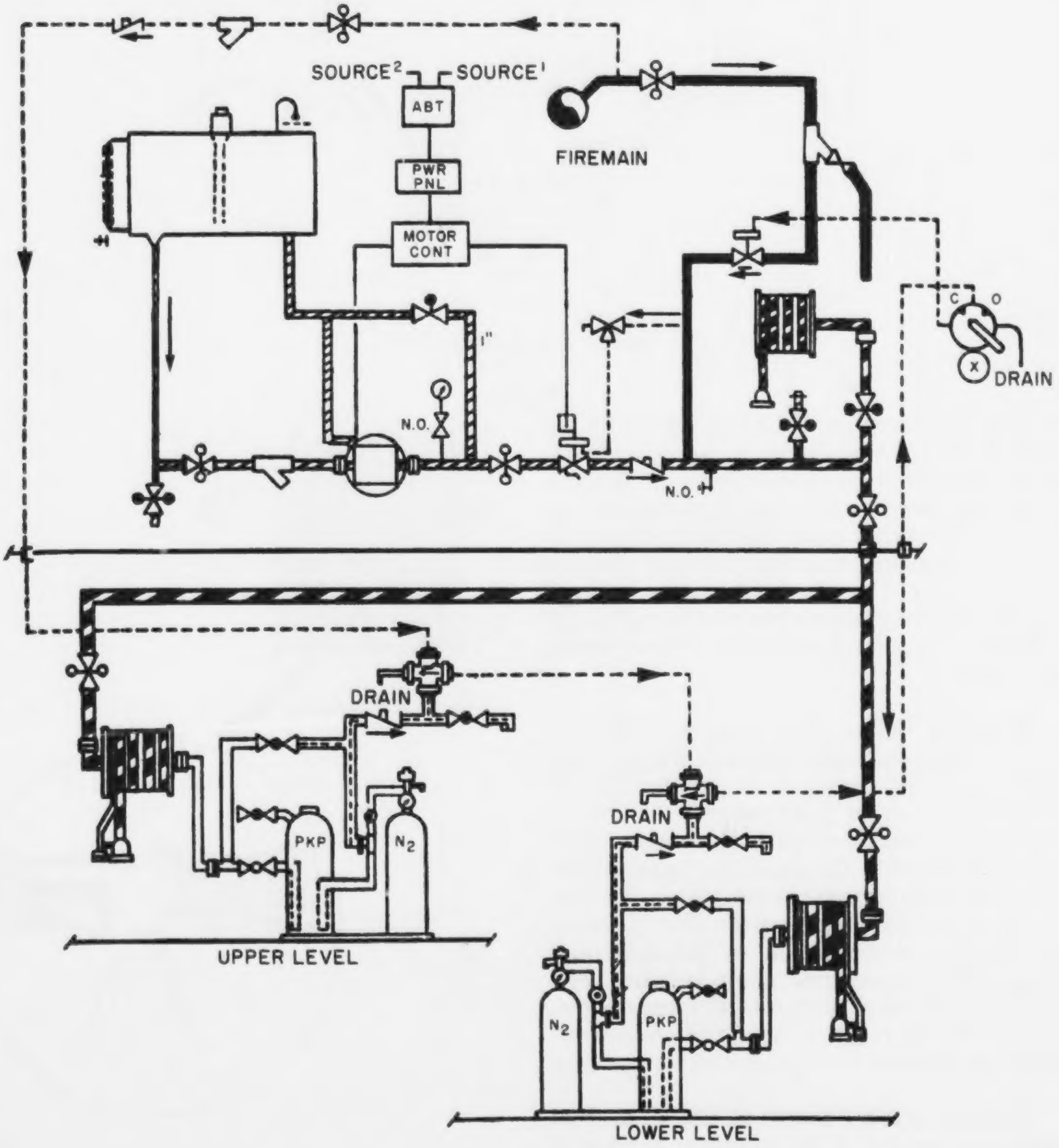

SOURCE^2
SOURCE^1
ABT
PWR PNL
MOTOR CONT
FIREMAIN
1"
N.O.
N.O.
C
O
X
DRAIN
DRAIN
DRAIN
PKP
N_2
UPPER LEVEL
PKP
N_2
LOWER LEVEL
8.484

Figure 5-26.—AFFF injection station (12 gpm).

the theory of operation for troubleshooting and maintenance procedures. The following paragraphs will discuss the theory and operation of AFFF generating systems. The discussions will make use of the AFFF equipment and components that you studied earlier in this chapter.

12-gpm Injection System

The 12-gpm injection system will pump AFFF concentrate into the distribution piping at a fixed rate of 12 gpm, combining the concentrate and the water to produce the AFFF/water solution (fig. 5-26). The system is activated by venting the hycheck valve (water control valve) through an actuation control valve. The control line for the powertrol valve is connected downstream of the hycheck valve. As water is discharged through the hycheck valve, the water flow pressurizes the distribution piping and the operating chamber of the powertrol valve, thus causing the valve to open. A limit switch is installed on the powertrol valve. It energizes the motor controller and pump assembly (fig. 5-27) (positive displacement, sliding vane).

Two-Speed Injection System

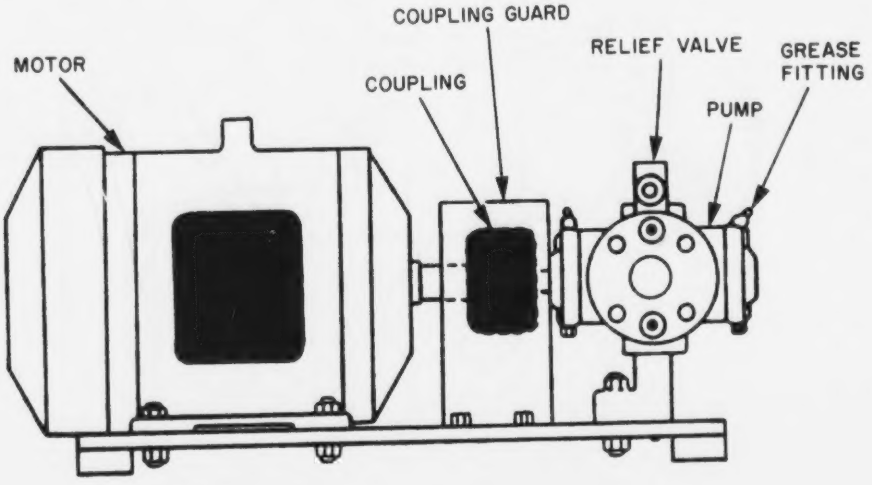
The two-speed injection system (fig. 5-28) will inject AFFF concentrate into the water stream at a rate of 27 or 65 gpm, depending on the demand for the fire-fighting agent that is placed on the system. The system is actuated by activating an SOPV, electrically or manually. The SOPV will vent the operating chamber of the hycheck valve and pressurize the operating chamber of the powercheck valve. The switch assembly of an SOPV will cause electrical activation of the pump assembly (positive displacement, sliding vane) via the motor controller. The AFFF concentrate is pumped into the distribution piping where it combines with the water flow. This in turn produces the AFFF/water solution. The two-speed injection station can be activated locally with the local controls on the motor controller.

Single-Speed Injection System

The single-speed injection system will inject AFFF concentrate into the water stream of the countermeasure washdown (CMWD) system at a rate of 60 or 80 gpm, depending on the type of pump used, thus producing AFFF/water solution. This system is currently installed onboard aircraft carriers (CVs). The system is actuated by an SOPV. The SOPV will pressurize the operating chamber of the CMWD system powertrol valve. When the activation switch for the CMWD system powertrol valve is activated, an electrical signal from the switch will activate the pump assembly (positive displacement, sliding vane) via the motor controller. On some aircraft carriers, the activation of the single-speed injection system and countermeasure washdown system is accomplished with independent switches when the AFFF/water solution is desired.

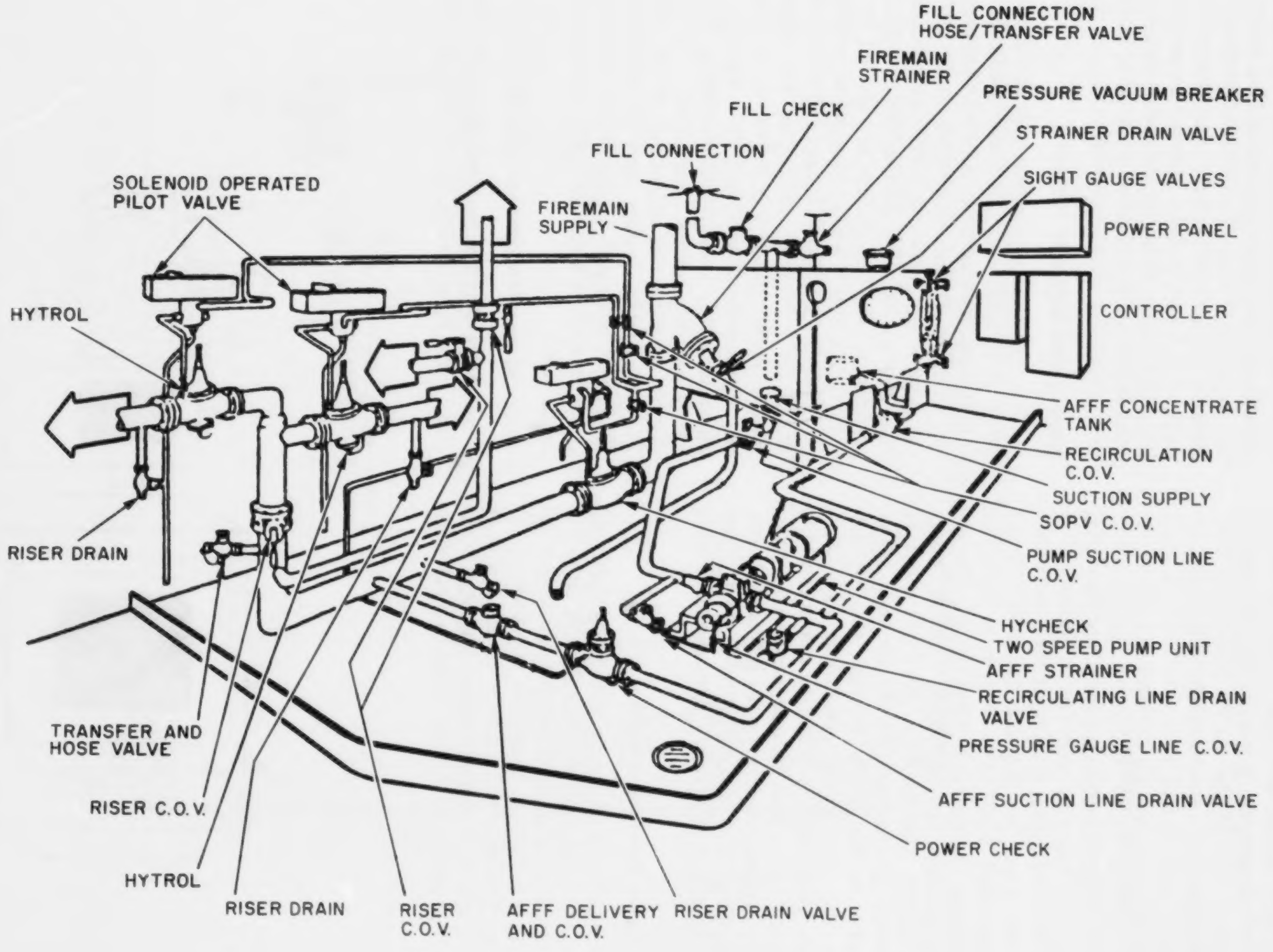
Water Motor Proportioner (FP-180)

The FP-180 water motor proportioner system (fig. 5-29) is activated by venting the hytrol



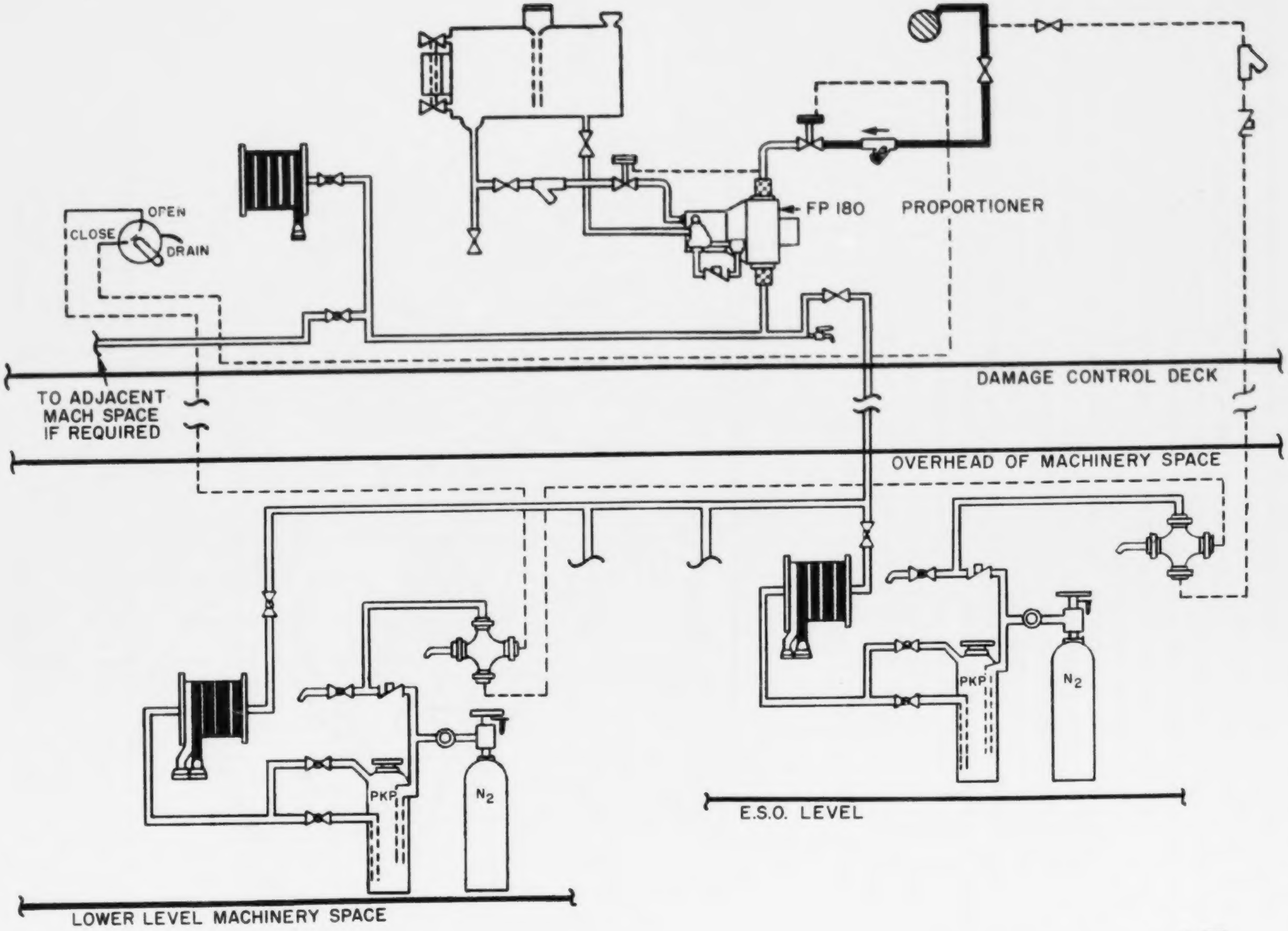
8.485

Figure 5-27.—12-gpm AFFF concentrate pump.


FILL CONNECTION
HOSE/TRANSFER VALVE
FIREMAIN STRAINER
PRESSURE VACUUM BREAKER
FILL CHECK
STRAINER DRAIN VALVE
FILL CONNECTION
SIGHT GAUGE VALVES
SOLENOID OPERATED PILOT VALVE
FIREMAIN SUPPLY
POWER PANEL
HYTROL
CONTROLLER
AFFF CONCENTRATE TANK
RECIRCULATION C.O.V.
SUCTION SUPPLY
SOPV C.O.V.
RISER DRAIN
PUMP SUCTION LINE C.O.V.
HYCHECK
TWO SPEED PUMP UNIT
AFFF STRAINER
RECIRCULATING LINE DRAIN VALVE
TRANSFER AND HOSE VALVE
PRESSURE GAUGE LINE C.O.V.
RISER C.O.V.
AFFF SUCTION LINE DRAIN VALVE
POWER CHECK
HYTROL
RISER DRAIN
RISER C.O.V.
AFFF DELIVERY AND C.O.V.
RISER DRAIN VALVE

8.486

Figure 5-28.—Two-speed injection pump system.


OPEN
CLOSE
DRAIN
FP 180
PROPORTIONER
TO ADJACENT MACH SPACE IF REQUIRED
DAMAGE CONTROL DECK
OVERHEAD OF MACHINERY SPACE
PKP
N_2
PKP
N_2
E.S.O. LEVEL
LOWER LEVEL MACHINERY SPACE

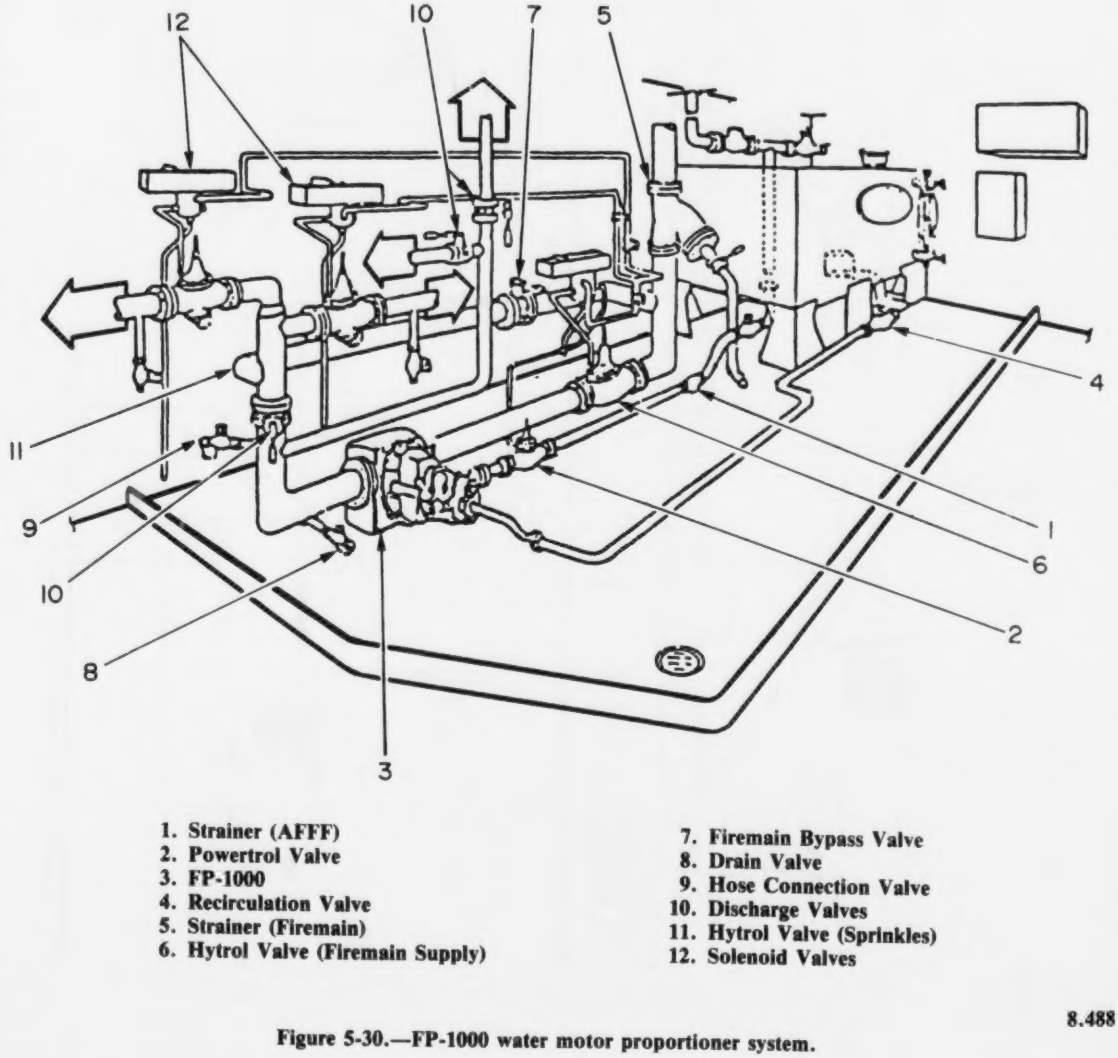
8.487

Figure 5-29.—Typical FP-180 water motor proportioner system.

(water control valve) through an actuation control valve. The control line for the powertrol valve is connected downstream of the hytrol valve. As water is discharged through the hytrol valve, the water flow pressurizes the inlet hose of the water motor proportioner and the operating chamber of the powertrol valve, thus causing the valve to open. As the water flows through the water motor proportioner, the rotary gear pump injects a metered amount of AFFF concentrate into the water stream of the water motor proportioner discharge, thus producing AFFF/water solution. Some ships use powertrol valves for both the water and the AFFF concentrate control valves. The basic theory of operation is the same for both.

Water Motor Proportioner (FP-1000)

The FP-1000 water motor proportioner system (fig. 5-30) is activated by an SOPV electrically or manually. The SOPV will vent the operating chamber of the hytrol valve and pressurize the operating chamber of the powertrol valve. As the water is discharged through the hytrol valve, the water flow will pressurize the water motor inlet. This will cause the rotary gear pump to inject a metered amount of AFFF concentrate into the water stream of the water motor proportioner discharge, thus producing the AFFF/water solution. A centrifugal pump assembly is sometimes installed in conjunction with the water motor proportioner. This is done when the inlet flow



1. **Strainer (AFFF)**
2. **Powertrol Valve**
3. **FP-1000**
4. **Recirculation Valve**
5. **Strainer (Firemain)**
6. **Hytrol Valve (Firemain Supply)**
7. **Firemain Bypass Valve**
8. **Drain Valve**
9. **Hose Connection Valve**
10. **Discharge Valves**
11. **Hytrol Valve (Sprinkles)**
12. **Solenoid Valves**

8.488

Figure 5-30.—FP-1000 water motor proportioner system.

rates to the water motor may drop below 200 gpm, where the proportioner will not produce an effective AFFF/water solution. A pressure switch is used to activate the pump assembly via the motor controller to boost the pressure of AFFF concentrate entering the rotary gear pump. This arrangement will produce an effective AFFF/ water solution when the flow rates drop below 200 gpm.

Balanced-Pressure Proportioner (Type II)

The balanced-pressure proportioner (fig. 5-31) proportions the correct amount of AFFF concentrate necessary to produce effective AFFF/ water solution over a wide range of flows and pressures. The system is actuated (fig. 5-32) by activating an SOPV, electrically or manually. The SOPV will vent the operating chamber of the hycheck valve and pressurize the operating chamber of the powertrol valve. The switch assembly of a SOPV will cause electrical activation of the pump assembly (positive displacement, sliding vane or rotary gear) via the motor controller. The pump assembly will pressurize the AFFF concentrate piping to the demand proportioner and balancing valve. Water flow through the proportioner will move the water float towards the large opening of the water sleeve, depending on the gallonage required for fire fighting. The AFFF concentrate float is directly controlled by the movement of the water float, thus influencing the amount of AFFF concentrate that enters the water stream. Water and AFFF concentrate enter the proportioner at the same pressure; hence, the name *balanced-pressure proportioning system*. The balanced-pressure theory is a direct result of the balancing valve. One sensing line is located downstream of the hycheck

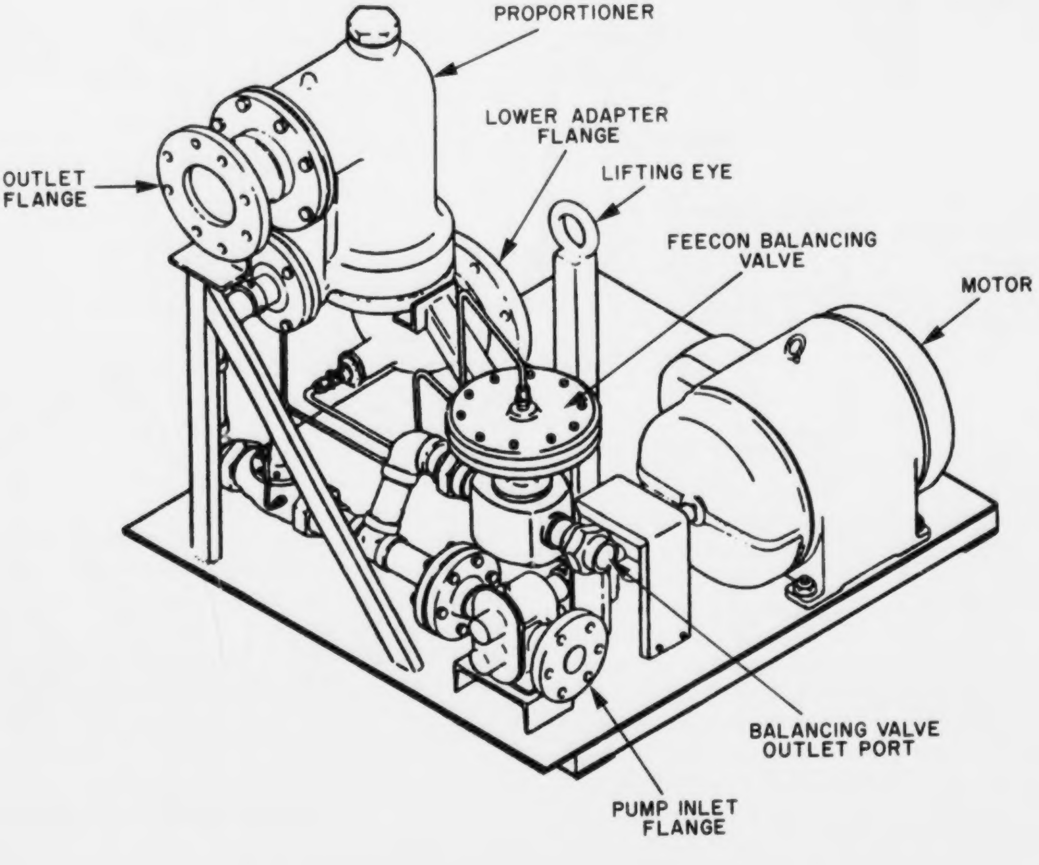


Figure 5-31.—Balanced-pressure proportioner.

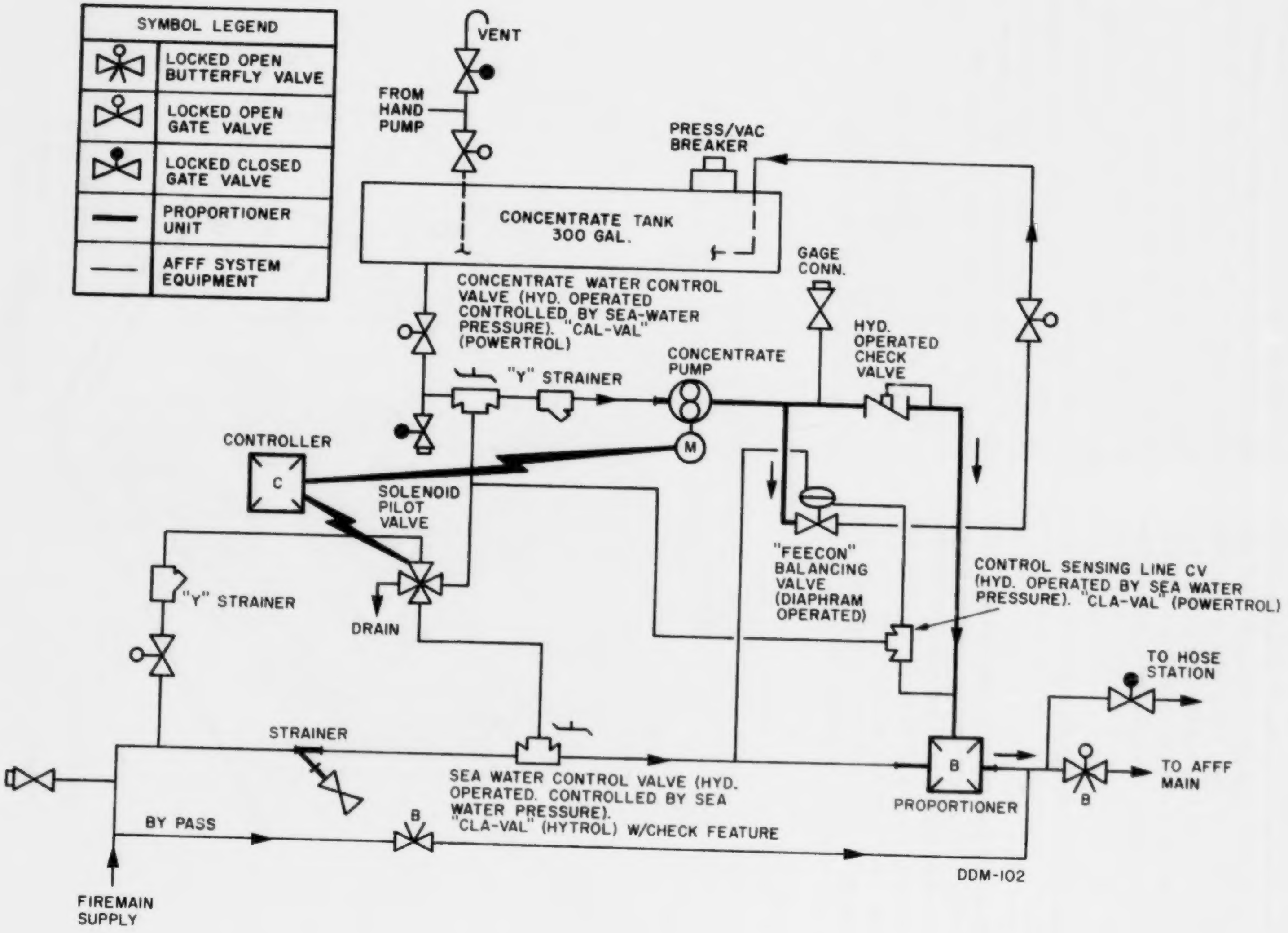

SYMBOL LEGEND
LOCKED OPEN BUTTERFLY VALVE
LOCKED OPEN GATE VALVE
LOCKED CLOSED GATE VALVE
PROPORTIONER UNIT
AFFF SYSTEM EQUIPMENT
VENT
FROM HAND PUMP
PRESS/VAC BREAKER
CONCENTRATE TANK 300 GAL.
GAGE CONN.
CONCENTRATE WATER CONTROL VALVE (HYD. OPERATED CONTROLLED BY SEA-WATER PRESSURE). "CAL-VAL" (POWERTROL)
HYD. OPERATED CHECK VALVE
CONCENTRATE PUMP
"Y" STRAINER
CONTROLLER
C
M
SOLENOID PILOT VALVE
"FEECON" BALANCING VALVE (DIAPHRAM OPERATED)
CONTROL SENSING LINE CV (HYD. OPERATED BY SEA WATER PRESSURE). "CLA-VAL" (POWERTROL)
"Y" STRAINER
DRAIN
TO HOSE STATION
STRAINER
B
TO AFFF MAIN
B
SEA WATER CONTROL VALVE (HYD. OPERATED. CONTROLLED BY SEA WATER PRESSURE). "CLA-VAL" (HYTROL) W/CHECK FEATURE
PROPORTIONER
BY PASS
B
DDM-102
FIREMAIN SUPPLY

Figure 5-32.—Type II balanced-pressure proportioner system.

8.490

valve, and another is located upstream of the AFFF concentrate discharge check valve. They route the water pressure and AFFF concentrate pressure to the operating chambers of the balancing valve. The water-sensing line is piped to the top operating chamber and the AFFF concentrate-sensing line is piped to the lower operating chamber. As the gallonage is increased or decreased through the proportioner due to demand, the water pressure will decrease or increase respectively in the water operating chamber. When this happens, the balancing valve will automatically regulate the AFFF concentrate pump discharge pressure to equal the water pressure. The balancing valve will constantly recirculate the AFFF concentrate to the service tank. The gallonage of AFFF concentrate returned to the service tank through the recirculating piping varies. It depends on the position of the balancing valve, which is directly controlled by pressure in the water operating chamber. Water and AFFF concentrate will be thoroughly proportioned in the proportioner due to the venturi principle and then discharged into the distribution piping.

Balanced-Pressure Proportioner (Type III)

The purpose, actuation of system, and balancing valve theory for the type III proportioner are identical to those of the type II proportioner. The type III proportioners house no internal moving parts and use the venturi principle to allow for complete mixing of AFFF/water solution. The gallonage of AFFF concentrate entering the proportioner is controlled by an orifice plate. The size of the orifice is determined by the maximum demand for fire-fighting agent placed on the system. The water-sensing line connection for the type III proportioner is piped directly from the proportioner body to the balancing valve. Type III proportioner systems (fig. 5-33) use a positive displacement, sliding vane pump.

Advantages and Disadvantages

The preceding paragraphs have discussed all AFFF generating systems currently installed aboard naval ships. Some of the advantages and disadvantages of AFFF generating systems are as follows:

- Balanced-pressure systems have the advantage of being cost effective in the use of AFFF concentrate. The disadvantage is the pressure drop, which is a pressure loss between the inlet and discharge openings of the proportioner.

- Injection systems have the advantage of no pressure drop, but a disadvantage in the high use of AFFF concentrate.

- A disadvantage is that the positive displacement pump rated for 60 gpm will inject only that amount, regardless of the demand for the fire-fighting agent.

- A disadvantage of the water motor proportioners is pressure drop and no AFFF/water solution or water is available if the proportioner does not rotate.

TWIN AGENT EQUIPMENT

The twin agent equipment gets its name from the use of two fire-fighting agents: AFFF and potassium bicarbonate (PKP). The twin agent system is built into the ship, while the twin agent unit (TAU) is self-contained and mounted on a movable tractor.

Twin Agent System

The twin agent system (figs. 5-34 and 5-35) consists of an AFFF generating station and a dry-chemical unit. The twin agent concept gives the fire party the ability to combat fuel oil spray fires and liquid pool fires. The AFFF nozzle should be used on liquid pool fires. The dry-chemical nozzle should be used on fuel oil spray fires. When both a fuel oil spray fire and a liquid pool fire exist simultaneously, both AFFF and dry chemicals should be discharged at the same time. On all ships that have dry-chemical capability, except battleships, the dry-chemical unit actuates the AFFF generating station through the 3-way interlock valves or a pressure switch.

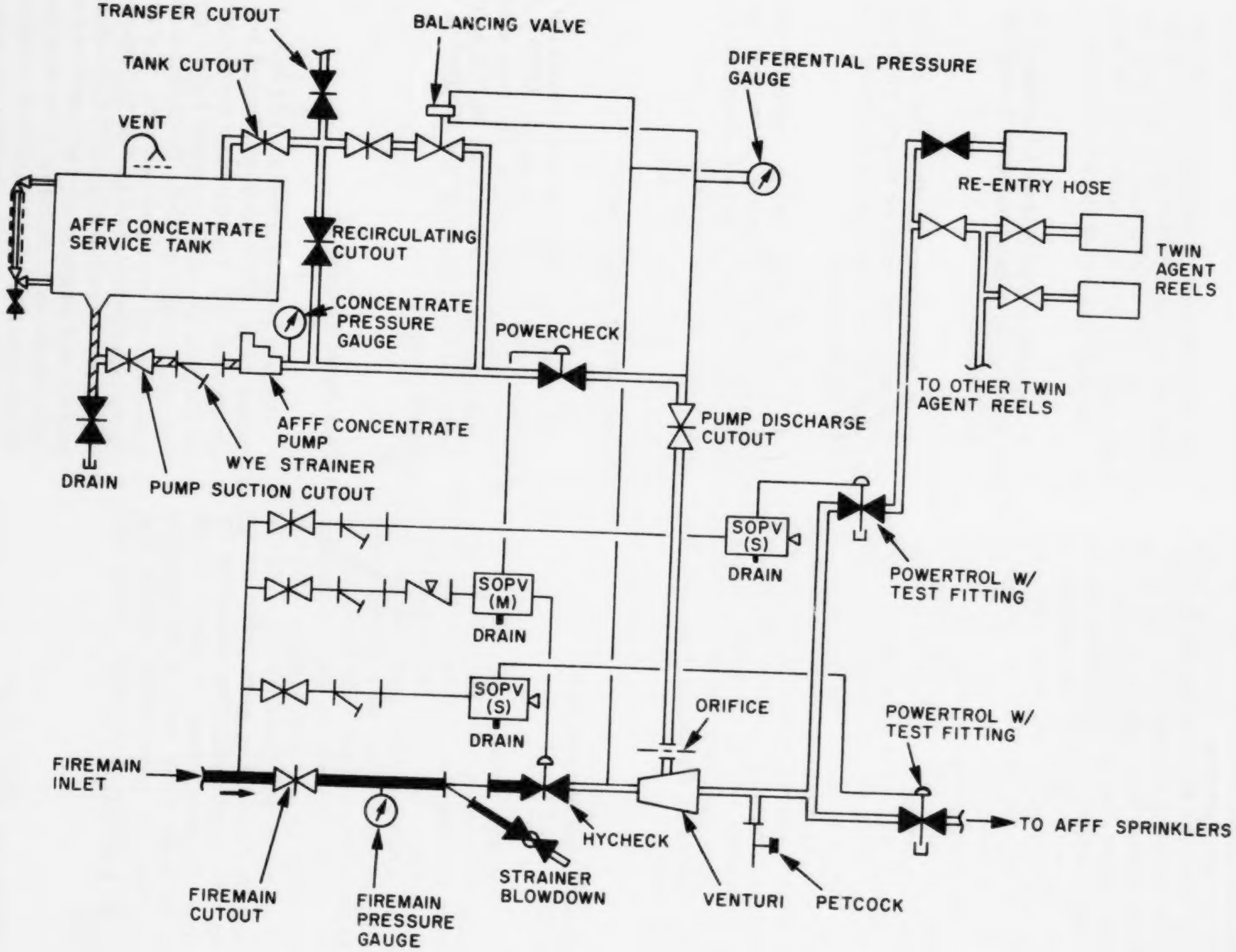

TRANSFER CUTOUT
BALANCING VALVE
TANK CUTOUT
DIFFERENTIAL PRESSURE GAUGE
VENT
AFFF CONCENTRATE SERVICE TANK
RECIRCULATING CUTOUT
RE-ENTRY HOSE
TWIN AGENT REELS
CONCENTRATE PRESSURE GAUGE
POWERCHECK
TO OTHER TWIN AGENT REELS
AFFF CONCENTRATE PUMP
PUMP DISCHARGE CUTOUT
WYE STRAINER
DRAIN
PUMP SUCTION CUTOUT
SOPV (S)
DRAIN
POWERTROL W/ TEST FITTING
SOPV (M)
DRAIN
SOPV (S)
DRAIN
ORIFICE
POWERTROL W/ TEST FITTING
FIREMAIN INLET
TO AFFF SPRINKLERS
HYCHECK
STRAINER BLOWDOWN
FIREMAIN CUTOUT
FIREMAIN PRESSURE GAUGE
VENTURI
PETCOCK

Figure 5-33.—Type III balanced-pressure proportioner system.

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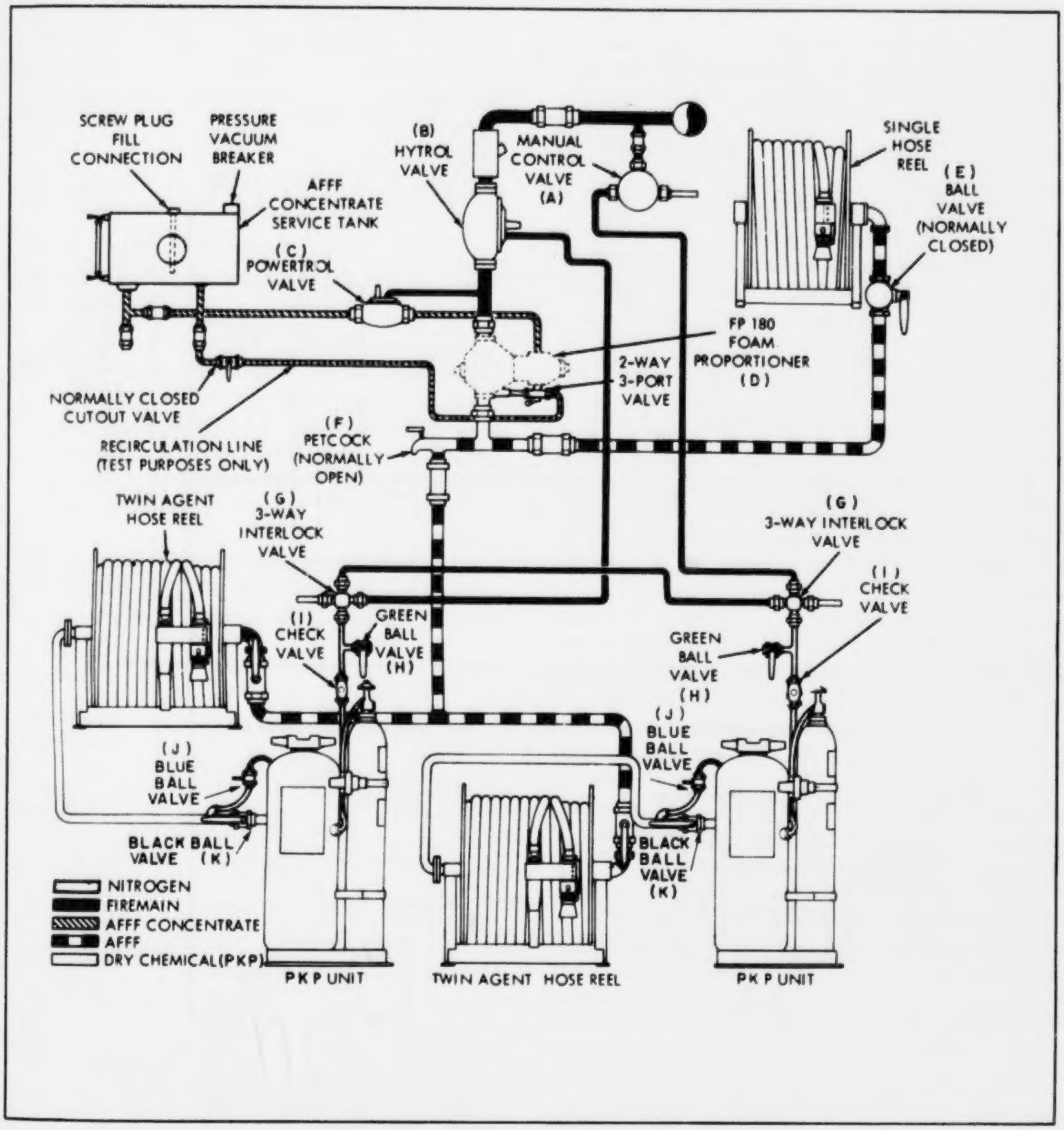

SCREW PLUG FILL CONNECTION
PRESSURE VACUUM BREAKER
(B) HYTROL VALVE
MANUAL CONTROL VALVE (A)
SINGLE HOSE REEL
(E) BALL VALVE (NORMALLY CLOSED)
AFFF CONCENTRATE SERVICE TANK
(C) POWERTROL VALVE
FP 180 FOAM PROPORTIONER (D)
2-WAY 3-PORT VALVE
NORMALLY CLOSED CUTOUT VALVE
RECIRCULATION LINE (TEST PURPOSES ONLY)
(F) PETCOCK (NORMALLY OPEN)
TWIN AGENT HOSE REEL
(G) 3-WAY INTERLOCK VALVE
(G) 3-WAY INTERLOCK VALVE
(I) CHECK VALVE
(I) CHECK VALVE
GREEN BALL VALVE (H)
GREEN BALL VALVE (H)
(J) BLUE BALL VALVE
(J) BLUE BALL VALVE
BLACK BALL VALVE (K)
BLACK BALL VALVE (K)
NITROGEN
FIREMAIN
AFFF CONCENTRATE
AFFF
DRY CHEMICAL (PKP)
PKP UNIT
TWIN AGENT HOSE REEL
PKP UNIT

8.492

Figure 5-34.—Flow diagram of twin agent system.

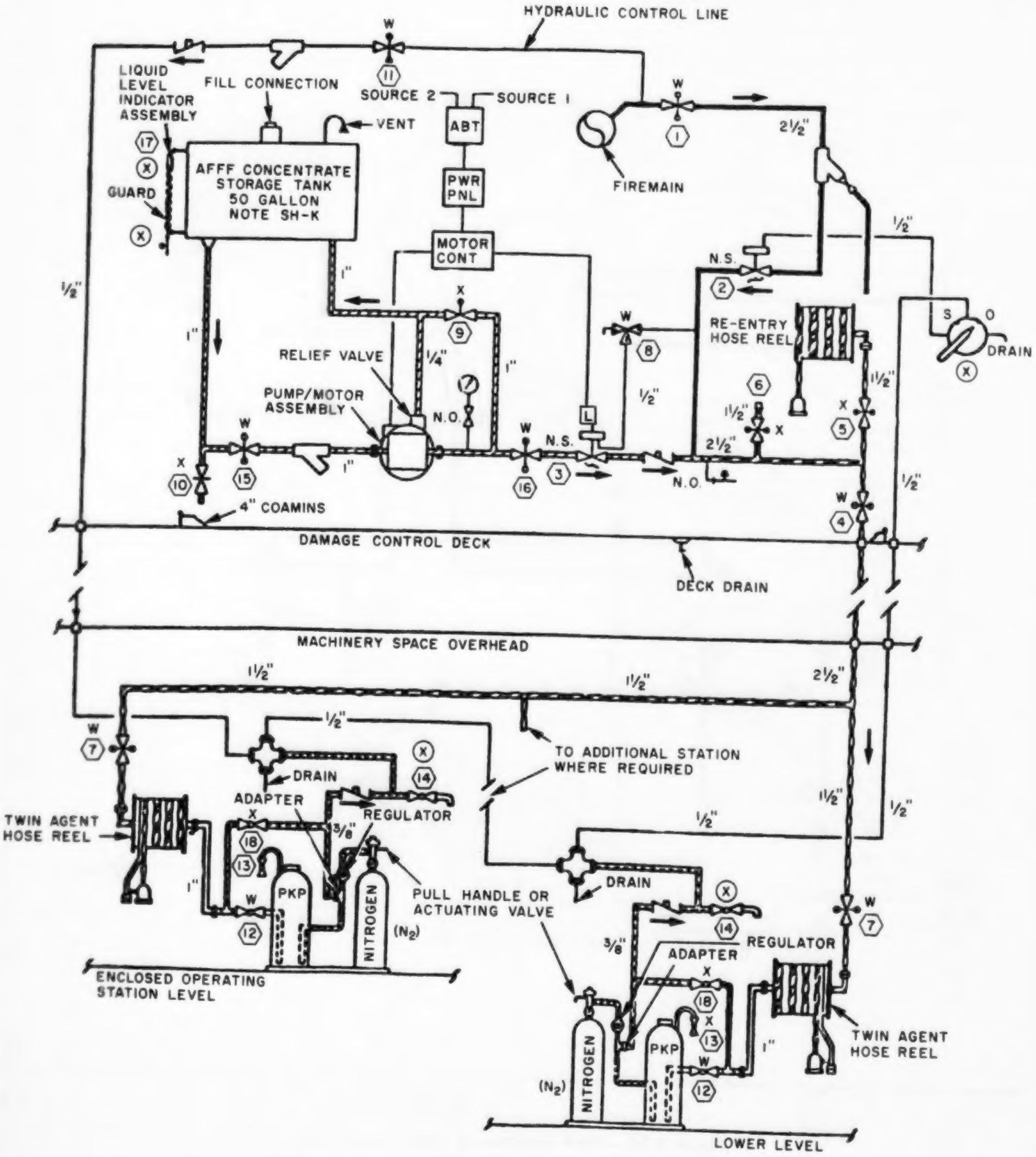

HYDRAULIC CONTROL LINE
W
11
LIQUID LEVEL INDICATOR ASSEMBLY
FILL CONNECTION
SOURCE 2
SOURCE 1
VENT
ABT
W
1
17
X
GUARD
X
AFFF CONCENTRATE STORAGE TANK 50 GALLON NOTE SH-K
PWR PNL
FIREMAIN
2½"
MOTOR CONT
½"
½"
1"
N.S.
2
X
9
RE-ENTRY HOSE REEL
S
O
DRAIN
X
1"
RELIEF VALVE
¼"
1"
W
8
½"
6
1½"
PUMP/MOTOR ASSEMBLY
N.O.
1½"
X
X
5
W
N.S.
2½"
X
10
W
15
1"
16
3
N.O.
½"
W
4
4" COAMINS
DAMAGE CONTROL DECK
DECK DRAIN
MACHINERY SPACE OVERHEAD
1½"
1½"
2½"
½"
W
7
X
14
TO ADDITIONAL STATION WHERE REQUIRED
DRAIN
ADAPTER
REGULATOR
TWIN AGENT HOSE REEL
X
⅜"
18
13
1½"
½"
½"
1"
W
12
PKP
NITROGEN
(N₂)
PULL HANDLE OR ACTUATING VALVE
DRAIN
X
W
7
14
REGULATOR
⅜"
ADAPTER
X
18
X
13
ENCLOSED OPERATING STATION LEVEL
NITROGEN
PKP
W
1"
TWIN AGENT HOSE REEL
(N₂)
12
LOWER LEVEL

Figure 5-35.—Twin agent fire-extinguishing system (electric pump).

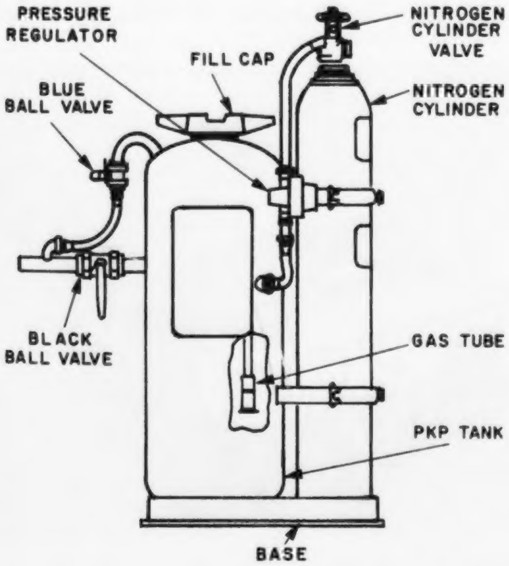
8.493

The dry-chemical unit (fig. 5-36) consists of a dry-chemical tank, nitrogen cylinder, regulator, twin agent hose reel, and various valves and piping that are necessary to operate the unit.

The dry-chemical tank holds 125 pounds of dry chemical (PKP). A large diameter threaded cap is provided for refilling the dry-chemical tank. The storage tank has the three piping connections listed below:

- One dry chemical discharge (black ball valve) to the twin agent hose reel
- One nitrogen inlet (from the nitrogen regulator)
- One nitrogen vent (yellow ball valve) to relieve the nitrogen pressure from the storage tank, or one nitrogen hose blowdown (blue ball valve) to vent the storage tank and blow down the dry-chemical hose

When the blue ball valve is installed in conjunction with the yellow ball valve, it will only blow down the dry-chemical hose. In this case, the yellow ball valve is used to vent the storage tank. When the blue ball valve is installed independently, it functions as a hose blowdown and a tank vent valve. Dry chemical is forced out of the storage tank by nitrogen gas stored in the nitrogen cylinder.



8.494

Figure 5-36.—Cutaway of PKP assembly of the twin agent system.

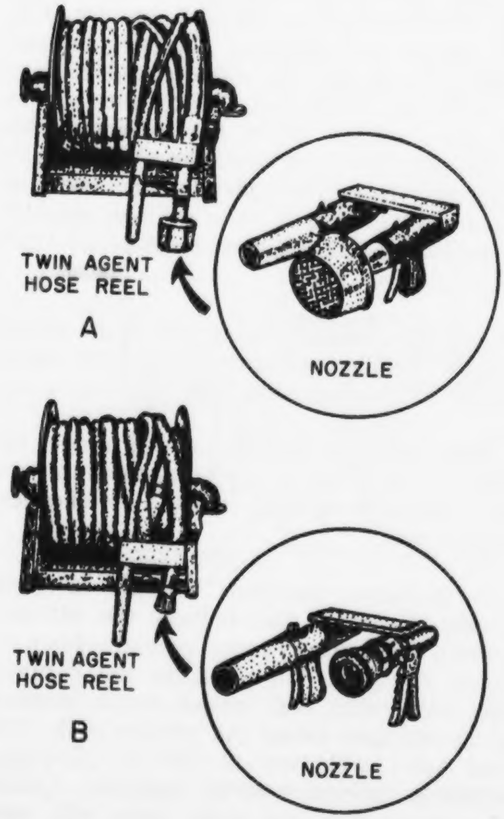
Nitrogen is stored for each dry-chemical unit in a separate nitrogen cylinder. The cylinder has a capacity of 110 cubic feet of nitrogen. The nitrogen is released from the cylinder to charge the dry-chemical storage tank by a quick-opening valve located on the cylinder's throat. This valve can be actuated by either the quick-opening (pull) handle or the handwheel. When the quick-opening handle is pulled, the valve opens immediately and charges the dry-chemical tank with nitrogen. This action pressurizes the 3-way interlock valve or pressure switch, which, in turn, actuates the AFFF generating station. Both the dry chemical and the AFFF/water solution are then available for fire fighting. The quick-opening valve is equipped with a safety device called a rupture disk. The rupture disk prevents excessive pressure buildup in the nitrogen cylinder and ruptures at 3,600 to 4,000 psig. Once the rupture disk has ruptured, all of the contents within the cylinder will be drained out. The nitrogen is stored in the cylinder at a maximum pressure of 2,200 psig. The cylinder must be replaced when the pressure drops below 1,500 psig.

Some dry-chemical installations do not actuate the AFFF generating station. Instead the station may be actuated by an SOPV.

The handwheel can also be used to open the valve, but it is much slower and reduces the initial surge of nitrogen into the dry-chemical storage tank.

A pressure regulator on the nitrogen cylinder discharge line reduces the nitrogen pressure from the cylinder pressure down to 210 to 230 psig. The regulator has a preset relief valve that will release excess pressure before nitrogen enters the storage tank. The relief valve will vent at 260 or 325 psig, depending on the type of regulator. Unlike the rupture disk, the relief valve will reset when the pressure drops below the lift pressure of 260 or 325 psig.

The twin agent hose reel (fig. 5-37) consists of 50 feet of 1 1/2-inch noncollapsible hose for the AFFF/water solution, 50 feet of 3/4-inch noncollapsible hose for dry chemical, an AFFF nozzle, and a dry-chemical nozzle. Two types of AFFF nozzles are used with the twin agent hose reel. One nozzle (fig. 5-37, view A) is rated for a constant flow of 90 gpm with a nonadjustable fog pattern. The other (fig. 5-37, view B) is rated for a constant flow of 95 gpm with an adjustable fog pattern and a variable-stream pattern nozzle. Both nozzles have pistol grips and are trigger operated. The dry-chemical nozzle discharges dry chemical at a rate of 2 pounds per second. It throws a tight stream of dry chemical about 10 feet before the stream breaks up and becomes a rolling cloud. The AFFF and dry-chemical nozzles are attached to a tie-bar for ease in handling.



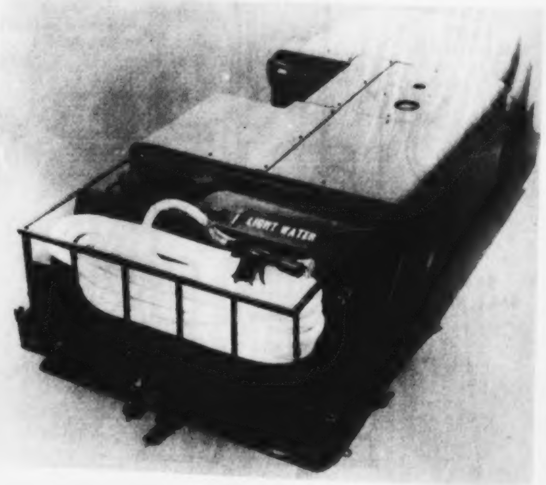
8.495
Figure 5-37.—Configurations of the twin agent system.

Twin Agent Unit

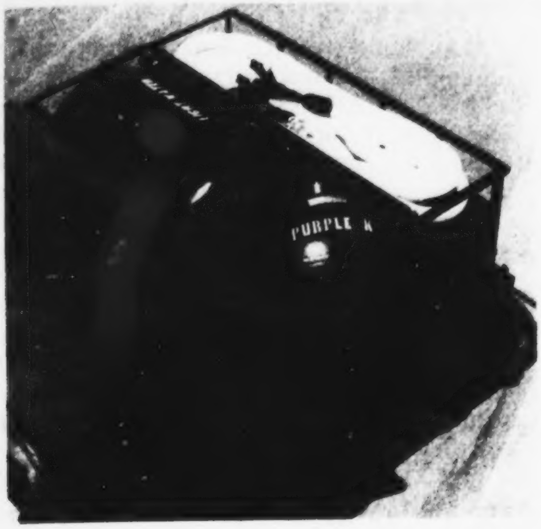
A mobile fire-extinguishing system that uses a combination of AFFF and dry powder has been developed and approved for shipboard use. The twin agent unit (TAU) is mounted on a movable tractor (figs. 5-38 and 5-39). The TAU is used primarily to rescue pilots. It is operated by one person and is extremely effective. Very large fires, including gasoline fires on aircraft carriers, have been put out in less than 1 minute with the TAU.

The TAU uses AFFF and PKP. When the PKP has interrupted the chemical reaction and slowed down combustion, the AFFF is applied. AFFF floats on the surface of the fuel and prevents reflash. Using AFFF to prevent a reflash is very important because PKP gives no reflash protection.

The TAU has a sphere containing 200 pounds of PKP and a cylinder containing 80 gallons of AFFF in solution. A nitrogen cylinder is also installed on the TAU. The nitrogen is used to pressurize both the PKP sphere and the AFFF cylinder. The nitrogen cylinder should be fully charged to 2,400 psi when the unit is first put into operation. The pressure regulator on the nitrogen cylinder is preset to reduce the pressure to 230 psi for the PKP sphere and for the AFFF cylinder. The two rubber discharge hoses have a working-pressure rating of 400 psi. They are 1 inch in diameter for AFFF and 3/4 inch in diameter for PKP. The two hoses are married together for easy handling. The twin pistol-grip



103.146
Figure 5-38.—Twin agent unit (view 1).



103.147

Figure 5-39.—Twin agent unit (view 2).

nozzles are joined together; one nozzle is operated with one hand and the other with the other hand. This allows selection of the agent desired and also makes for easy handling.

A separate valve is used to allow each agent to flow into its hose line. A 100-foot hose allows rapid running out to the fire areas. A relief valve is not provided for the sphere. The sphere must be bled through the hose. Relief valves are provided for the AFFF tank and the pressure regulator.

The TAU requires some preventive maintenance. Drain the PKP hose after each use to prevent clogging of the unit. Check the nitrogen cylinder to verify that it has the proper pressure; each nitrogen cylinder supplied for the TAU has a gauge attached. Have the cylinders recharged whenever their pressure drops to 1,500 psi. Note that the TAU does NOT require lubrication.

Observe the following safety precautions when using the TAU:

- Use only nitrogen to pressurize the TAU. NEVER use oxygen or any other compressed gas.

- When preparing to use the TAU, make sure that all of the fill caps are airtight and that they are not cross threaded. Also, be sure that all hose connections are tight.

- When preparing to refill the unit or to secure it, be sure that the PKP sphere and the AFFF cylinder are depressurized before removing the fill caps. Do NOT stand over the fill caps when you remove them. Do NOT stand in front of the pressure relief valve when you release pressure.

AFFF SPRINKLER SYSTEM

Sprinkler systems are a convenient and quick method for the fire party to apply AFFF/water solution or water to large areas of burning fuel. The system consists of a large header pipe with smaller branch connections and attached sprinkler heads. A sprinkler group control valve (powertrol or hytrol with test connection) will control the discharge flow to the sprinkler heads. The group control valve may be actuated by an SOPV or a manual control valve. Some sprinkler systems are activated by a manually operated cutout valve. Actuation controls for the group control valves may be located in primary flight control, the navigational bridge, helo control, a conflagration station, locally at the AFFF generating station, and at various locations throughout the ship, depending on the sprinkler system installation and type of ship. An AFFF sprinkler system is a subsystem of AFFF generating systems. Some of the different types of sprinkler systems aboard naval ships are listed below:

- The bilge sprinkler is located in the main and auxiliary machinery spaces with the sprinkler heads installed below the lower level deck plates.

- The overhead sprinkler system is installed in the overhead of helo and hangar bays, well decks, vehicle cargo holds, and fuel pump rooms. Some diesel-powered ships have the overhead sprinkler system installed in the main machinery space.

- The flush-deck system uses the countermeasure washdown flush-deck nozzles to discharge AFFF/water solution during flight deck and helo deck fires. This capability is currently available to all aircraft carriers, helicopter carriers, and some auxiliary and combatant ships.

- The deck-edge sprinkler sprays AFFF/water solution over the flight deck of aircraft carriers, helicopter carriers, and battleships. The system consists of spray nozzles that are positioned at the deck-edge combing of the port and starboard sides on helicopter and flight decks. The nozzles project the AFFF/water solution across the deck in an arc pattern to spray over the top of the burning fuel and aircraft.

AFFF TRANSFER SYSTEMS

AFFF generating stations use large volumes of AFFF concentrate during fire fighting. The service tank alone may not contain enough concentrate to combat a conflagration-type fire. Transfer capabilities are available to replenish the AFFF concentrate service tanks.

The installed system consists of a reserve transfer pump (positive displacement, sliding vane or centrifugal), reserve storage tanks, and associated piping and valves. The transfer system can deliver AFFF concentrate to on-station service tanks via a transfer main. The transfer main consists of a large pipe, with smaller branch connections interconnecting the AFFF service and storage tanks. This feature gives the on-station concentrate pump the capability of delivering AFFF concentrate into the transfer main. Once the transfer main is pressurized, either by the reserve pump or by the on-station pump, all AFFF generating station service tanks can be replenished. On-station pumps used in conjunction with jumper hoses and hose connection valves may be used to transfer AFFF concentrate. Some ships can replenish the service tanks with 55-gallon containers located near the generating station. They do this with an installed hand-operated pump or air-regulated transfer system. The air-regulated transfer system may be used to replenish reserve storage tanks. Ships may replenish service tanks or storage tanks by manually dumping AFFF concentrate from 5-gallon containers via a fill connection.

AFFF TESTING EQUIPMENT

AFFF concentrate and AFFF/water solution must be tested periodically to ensure that the fire party has an effective agent to combat class BRAVO (B) fires. To accomplish the test, you must have a basic understanding of the equipment used during the test. The following paragraphs will discuss the hand refractometer and the quantab chloride titrator strip.

Refractometer

The hand refractometer gives accurate readings of total dissolved solids in aqueous solutions. If an AFFF generating system is tested according to procedures, the refractometer reading will show the percent of solids present. For the readings to be meaningful, you must draw samples from the same water source and AFFF concentrate service tank that were used to generate the AFFF/water solution. If a ship has 20 AFFF generating systems, then you must take 20 AFFF concentrate samples and 20 AFFF/water solution samples. Use the refractometer to determine the percent of solids present in the aqueous solution samples. Once you have the readings, you can determine the percent of AFFF concentrate that is being proportioned with water by using the following formula:

$$RS - RW = A$$

$$RT - RW = B$$

$$\frac{A}{B} \times 100 = \text{PERCENT OF AFFF CONCENTRATE}$$

Where:

RS = the hose sample (AFFF/water solution)

RT = the service tank sample (AFFF concentrate)

RW = the water sample

Quantab Chloride Titrator

Quantab chloride titrator strips are used to measure salt (chloride) in aqueous solutions. Seawater contains approximately 20,000 ppm (parts per million) of chloride. The allowable limit for chloride contamination of AFFF concentrate is 2,000 ppm, which is equivalent to a 10 percent contamination. All approved AFFF concentrates have been subjected to 10 percent seawater contamination tests and have passed corrosion tests for metals approved in AFFF generating systems. Contamination above the 10 percent limit by seawater causes two problems: First, AFFF generating system components will corrode; second, improper AFFF/water solutions will result in an ineffective fire-fighting agent.

If contamination exceeds 2,000 ppm, the source of contaimination must be identified and corrected before dumping the contents of the AFFF concentrate tank. Clean all AFFF concentrate components before replenishing the service tank. Carry out all AFFF testing procedures in accordance with the planned maintenance requirements.

MAGAZINE SPRINKLER SYSTEMS

Sprinkler systems are used for emergency cooling of, and fire fighting in, magazines, ready-service rooms, ammunition and missile handling areas. A magazine sprinkler system consists of a network of pipes. These pipes are secured to the overhead and connected by a sprinkler system control valve to the ship's firemain system. The pipes are fitted with spray heads or sprinkler-head valves. They are arranged so that the water forced through them showers all parts of the magazine or ammunition and missile handling areas. A modern sprinkler system can wet down all exposed bulkheads at the rate of 2 gallons per minute per square foot. It can sprinkle the deck area at the rate of 4 gallons per minute per square foot. Magazine sprinkler systems can completely flood their designated spaces within an hour. To prevent unnecessary flooding of adjacent areas, all compartments equipped with sprinkler systems are watertight. Upper deck handling and ready-service rooms are equipped with drains that limit the water level to a few inches.

The two basic types of hydraulically controlled sprinkler systems are the firemain-operated dry type and the firemain-operated wet type. Both types may be found on the same ship. However, the dry type is normally installed in gun ammunition magazines and the wet type in missile magazines. The Gunner's Mates maintain these sprinkler systems. However, you will need to consider what effect you will have on the sprinkler systems when you conduct planned maintenance on, or make repairs to, the firemain system.

FOG AND WATER CURTAINS

Nonautomatic fog heads are installed at specific boundary bulkheads on certain decks of ships such as transports and cargo ships. They put out transverse fog curtains to prevent the rapid spread of fires. These installations make it possible to sectionalize a ship for fire protection with a series of fog curtains.

Water curtains are installed on aircraft carriers that are not equipped with a hangar foam sprinkler system. The water curtains are used to sectionalize the hangar to provide fire protection. The water curtains have shovel-type open sprinkler heads and are installed athwarthship.

FIXED FOG-SPRAY INSTALLATIONS

In naval ships that have bulk stowage of gasoline, the hazard warrants the use of fixed fog-spray installations. These installations are not automatically operated. A fixed fog-spray installation consists of fixed overhead piping equipped with fog heads that are connected to two female hose connections. One of these connections is located on the opposite side of a boundary bulkhead of a protected area. The other is located on the deck above the protected area. Use a check valve in the piping area near each connection and a regular hose connection to furnish water to the system. To operate the system, connect a 2 1/2-inch hose to a fireplug and to one of the female connections. Water is then provided to the system.

DRY-CHEMICAL EXTINGUISHERS

Portable dry-chemical extinguishers (fig. 5-40) are used primarily on class B fires. The dry

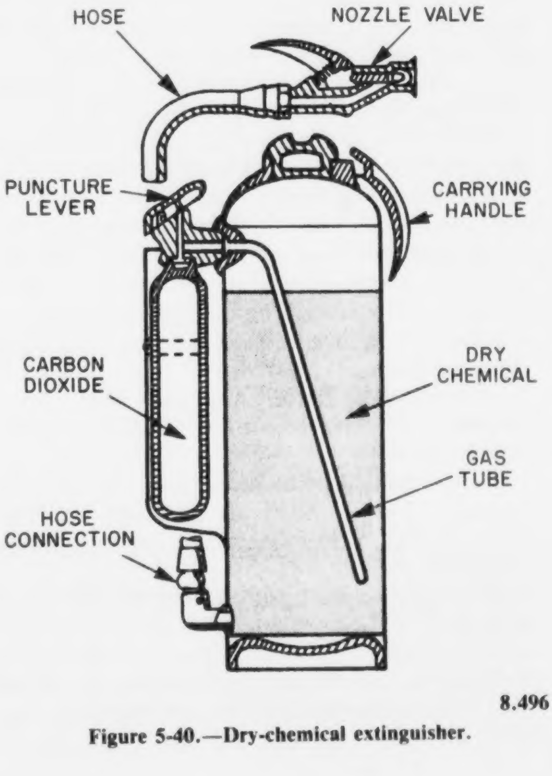


Figure 5-40.—Dry-chemical extinguisher.

chemical interrupts the chemical reaction that is fire and thereby slows down combustion. PKP is most often used in these extinguishers. This dry chemical is also safe and effective for use on class C fires; however, carbon dioxide (discussed later in this chapter) is preferred, because PKP will foul electrical and electronic components. Also, PKP should not be used on internal fires of gas turbines or jet engines unless absolutely necessary, because of its tendency to foul engines.

The most common size of PKP extinguisher is the 18-pound size. These extinguishers also come in a 9-pound and a 27-pound size. Most of the PKP extinguishers have a small CO_2 cartridge mounted on the outside of the extinguisher shell. This cartridge provides the propellent charge for the extinguisher. Do NOT pressurize the PKP extinguisher until you are ready to use it.

The procedure for operating a dry-chemical extinguisher is as follows:

1. Carry the extinguisher to the scene of the fire.
2. Pull the locking pin from the puncture lever marked PUSH.
3. Push the puncture lever down to cut the seal of the CO_2 cartridge. The extinguisher is now ready to use.
4. Approach the fire from the windward side, if possible. Hold the extinguisher in one hand and the nozzle in the other hand.
5. Discharge the dry chemical by squeezing the squeeze grip on the nozzle. Hold the nozzle firmly and direct the dry chemical at the base of the fire. Use a wide sweeping motion from side to side. This will apply a dense, wide cloud of dry chemical in the area. Remember that the extinguisher has a reach of approximately 20 feet.
6. Be certain that all of the fire in the area in which you are working is extinguished before you move in farther. If the fire appears to be too large or if there is a possibility of being outflanked or surrounded by flames, attack the fire with the assistance of two or more personnel using extinguishers.
7. Do not try to economize on the dry chemical. Use as much as necessary (and as many extinguishers as necessary) to completely extinguish the fire.
8. Always back up dry chemical with water or foam.

After a dry-chemical extinguisher has been used, invert the cylinder, squeeze the discharge lever of the nozzle, and tap the nozzle on the deck. This will release any pressure left in the cylinder and cartridge and any dry chemical left in the hose and nozzle. By inverting the cylinder, you prevent further discharge of dry chemical and conserve the powder. Make sure that dry chemical does not remain in the hose and nozzle; it will cake up and clog them.

To recharge a dry-chemical extinguisher, proceed as follows:

1. Invert the extinguisher and tap the side of the cylinder with the nozzle to knock down any loose dry chemical. Then bleed off the pressure.
2. Remove the fill cap. Do NOT lean over the top of the extinguisher when removing the fill cap.
3. Fill the cylinder with dry chemical only to the bend in the tube. The extra space allows the powder to be aerated when the cylinder is pressurized. This ensures that the powder will not be caked when it is applied.
4. Remove any dry chemical from the internal threads of the bottle and from the threads of the cap.
5. Replace the fill cap.

To install a new CO_2 cartridge, proceed as follows:

1. Lift the lever cutter assembly and insert the locking pin.
2. If the extinguisher is to be restowed in the rack, pass a lead wire seal through the locking pin and around the cutter lever.
3. Unscrew the expended CO_2 cartridge.
4. Remove the cap and gasket from a new CO_2 cartridge.
5. Screw the new cartridge, which has left-hand threads, into the female fitting of the cutter assembly.

CARBON DIOXIDE (CO_2) EQUIPMENT

Aboard ship, carbon dioxide fire-extinguishing equipment includes 15-pound CO_2 portable extinguishers, 50-pound CO_2 hose-and-reel installations, and 50-pound CO_2 installed flooding systems. The carbon dioxide is contained under pressure in steel cylinders. It is released through a CO_2 hose or fixed piping when the control valves are opened.

In all carbon dioxide extinguishers used by the Navy, the CO_2 is held under a pressure of 850 psia at 70 °F. (This pressure corresponds to a gauge pressure of 835.3 psig.) Any increase in temperature increases the pressure, and any decrease in temperature decreases the pressure. Since pressure builds up rapidly as the temperature increases, remember these three precautions to prevent the danger of explosion:

- Never fill cylinders to more than 68 percent of their volume capacity. The full volume capacity of a carbon dioxide cylinder is the amount of water at maximum density (39 °F) that the cylinder will hold.

- Cylinders are designed to withstand pressures up to 3,000 psi.

- Cylinders are equipped with safety release disks. The safety release disk ruptures at a pressure between 2,650 and 3,000 psi. The head of the safety nut is drilled to prevent recoil when the disk bursts. The bursting pressure depends upon the strength and thickness of the disk and the diameter of the hole in the safety nut. Therefore, replacement disks, nuts, and washers must be in accordance with the manufacturer's technical manual.

Because the pressure in a CO_2 cylinder will vary with a change in temperature, you cannot determine the amount of carbon dioxide in a cylinder by reading a pressure gauge. Instead, you must weigh the cylinders periodically to determine the amount of CO_2 in them. The intervals at which CO_2 cylinders must be weighed are specified in the 3-M Systems. The weight of each cylinder when empty and the weight when filled to capacity are stamped on the cylinder valve or written on a tag that is attached to the cylinder. In each case, the weight refers to the weight of the cylinder alone, without the horn and hose. Therefore, it is easy to check the weight of the carbon dioxide contained in any cylinder.

All CO_2 cylinders should be filled to their nominal capacity (by weight). The exception is 15-pound cylinders exposed to temperatures which may exceed 120 °F. These should be charged or bled down to 90 percent of nominal capacity, or 13.5 pounds. Carbon-dioxide cylinders used in fixed flooding and hose reel systems are a nominal 50-pound capacity. These cylinders can be installed in spaces at tempertures up to 135 °F with a full charge. Therefore, an undercharge or bleed down is not required.

When carbon dioxide is released from a cylinder at normal temperatures, it expands rapidly to about 450 times its stored volume. This rapid expansion causes the temperature to drop to about −110 °F. Most of the liquid carbon dioxide is vaporized and becomes a gas, but some of it forms snow. Do NOT allow this snow to contact your skin. Because of its very low temperature, carbon dioxide snow can blister the skin and produce a very painful injury.

Since CO_2 is 50 percent heavier than air, it tends to settle and cover the fire. A CO_2 blanket separates the air from the fire. The fire is thus smothered. If there is some wind or a draft, you should work so the carbon dioxide will be drawn or blown over the fire rather than away from it. Even though carbon dioxide reaches a very low temperature as it expands from the cylinder, it has only a very slight cooling effect on the fire. CO_2 is used primarily for its smothering effect, not for its cooling effect.

Carbon dioxide is most effective when it is used in confined spaces. When you are using CO_2, keep the compartment closed and secure the ventilation to prevent unnecessary dilution of the CO_2. Except in an emergency, you should not open a CO_2-flooded compartment for at least 15 minutes after it has been flooded. This delay is a precautionary measure to give the burned substances time to cool down so that they will not reignite when air is admitted to the compartment.

Do not attempt to use CO_2 unless you know what you are doing. In high concentrations, CO_2 will cause suffocation as rapidly as it will smother a fire, unless proper precautions are taken. You may enter a CO_2-flooded compartment, if necessary. However, you must use an approved Navy oxygen breathing apparatus or a hose (air-line) mask. Do NOT use a gas mask. It filters the air but does not provide the necessary oxygen.

PORTABLE CO_2 FIRE EXTINGUISHERS

The portable CO_2 fire extinguisher that is used on Navy ships is the 15-pound unit. This unit is recharged from a carbon dioxide transfer unit using a 50-pound CO_2 cylinder. These units are described below.

15-Pound CO_2 Fire Extinguisher

The standard Navy portable CO_2 fire extinguisher has a rated capacity (by weight) of 15 pounds of CO_2. The portable extinguisher is simple to operate. You just remove the locking pin and squeeze the squeeze-grip release valve. The squeeze-grip release valve makes a tight seal when pressure on the grip is released. Any unexpended CO_2 is contained inside the cylinder indefinitely without danger of leakage.

To operate the portable 15-pound CO_2 extinguisher, proceed as follows:

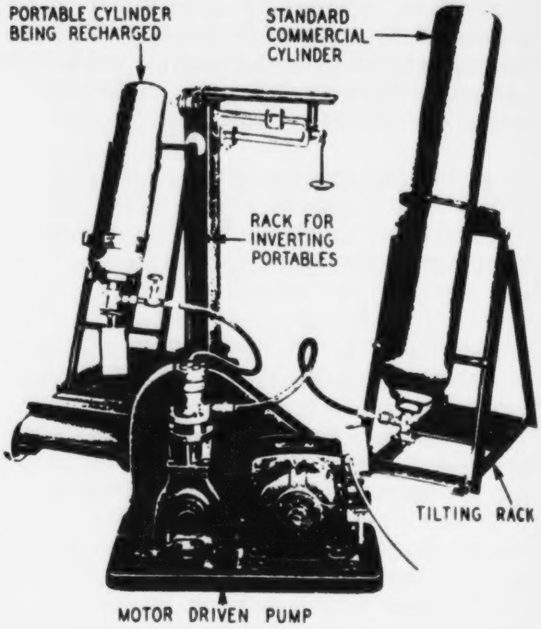
1. Carry the extinguisher in an upright position and approach the fire as closely as possible.
2. Remove the locking pin from the valve.
3. Grasp the horn handle. This handle is insulated to protect you against frostbite from the suddenly expanding CO_2.
4. Squeeze the release lever to open the valve and release the CO_2. Direct the flow of CO_2 toward the base of the fire. The maximum effective range of a 15-pound CO_2 extinguisher is 5 feet from the outer end of the horn. This distance is reduced if the wind is against you and increased if the wind is with you. If possible, attack the fire from the windward side to increase the range and also to protect yourself from the fire. Move the horn slowly from side to side and advance on the flames as they recede.
5. When conditions permit, close the valve. Continue to open and close the valve as the situation requires. When continuous operation is necessary or when the valve is to remain open for recharging, slip the D-yoke ring on the carrying handle over the operating handle. The operating handle should be in the depressed position when you put on the D-yoke ring. The D-yoke ring permits continuous operation as long as any CO_2 remains in the extinguisher.

Once a 15-pound cylinder has been used, it should be recharged before it is returned to its stowage place. Spare portable 15-pound CO_2 cylinders in storage must also be weighed at the required intervals and recharged whenever the weight has dropped to 13 1/2 pounds—that is, when there is a 10 percent loss. As previously noted, however, cylinders stowed in hot places are charged to only 90 percent of their capacity by weight, or in this case 13 1/2 pounds.

CO_2 Transfer Unit

A carbon dioxide transfer unit (fig. 5-41) is used to transfer CO_2 from a 50-pound cylinder to the 15-pound cylinders. The transfer unit consists of an electric motor and pump, a high-pressure hose, a control valve, adapters, and fittings.

Before operating the CO_2 transfer unit, be sure that the switch on the side of the motor is in the OFF position. Check the circuit from which the motor is to be energized and make certain that it is the same as that indicated on the nameplate on top of the motor. If 220-volt, 60-cycle, single-phase current is available, the hookup of the motor leads should be rearranged by an Electrician's Mate so the motor will operate on this circuit. A wiring diagram for operation on 220 volts is given on the motor nameplate. Check all CO_2 connections on both the inlet hose and the outlet hose (the 6-foot hose is the pump outlet hose). Make certain that all of the connections between the various parts are tight. This is very important because the CO_2 is stored under high pressure.


PORTABLE CYLINDER BEING RECHARGED
STANDARD COMMERCIAL CYLINDER
RACK FOR INVERTING PORTABLES
TILTING RACK
MOTOR DRIVEN PUMP

103.94

Figure 5-41.—CO_2 transfer unit.

To operate the transfer unit, proceed as follows but always in a well ventilated place:

CAUTION

> Do NOT close the valve of the cylinder being recharged or the shutoff valve in the pump outlet hose while the transfer unit is pumping.

1. With the transfer unit, scale, and tilt racks in place, check the supply cylinder. Use only the

50-pound commercial cylinders. The cylinder must be inverted.

2. Connect the pump inlet hose to the supply cylinder outlet. The connection adapter of this hose is fitted with a screen to prevent any foreign matter from getting into the transfer unit or into the cylinder being recharged. Do NOT open the supply cylinder valve.

3. Connect the pump outlet hose to the recharging adapter. The pump outlet hose is fitted with a shutoff valve. Check all connections and make sure they are correct and tight. When making the connections, use a wrench. Use a slow, steady, pulling motion. Do not jerk the wrench and do not hit it with a hammer.

4. Make certain that the shutoff valve in the pump outlet hose is in its tightly closed position. Make certain that the valve of the cylinder to be recharged is in its open position. Then completely open the valve of the supply cylinder.

5. Place the empty cylinder on the scale. If a rack is used, place the cylinder vertically; otherwise, set it horizontally.

6. Balance the scale and note the weight of the cylinder being recharged. On beam-type scales, set the scale to the weight of the cylinder plus its desired charge.

7. Open the shutoff valve in the pump outlet hose and allow the carbon dioxide in the supply cylinder to flow under its own pressure to the cylinder being recharged.

8. When the weight of the cylinder being recharged stops increasing, this is a sign that the carbon dioxide has stopped flowing under its own pressure from the supply cylinder. At this point, start the transfer unit and watch the scale carefully. The transfer pump must be started when all valves are open; otherwise, the CO_2 will not pass through the pump properly and may rupture the neoprene seal.

9. When the full capacity of the cylinder being recharged has been reached, perform the following procedures in rapid succession:
   a. Stop the transfer unit motor.
   b. Tightly close the shutoff valve in the pump outlet hose.
   c. Close the valve of the cylinder being recharged.

10. Disconnect the hose from the cylinder being recharged. Do this very slowly to allow the escape of the CO_2 that is trapped between the shutoff valve and the cylinder being recharged. Then remove the adapter.

11. Weigh the recharged cylinder carefully.

12. After the recharging is completed, close the supply cylinder valve tightly. Open the shutoff valve in the pump outlet hose very slowly and allow all the carbon dioxide in the unit to be discharged to the atmosphere.

The carbon dioxide transfer unit should be maintained in accordance with the manufacturer's instructions. Some parts require lubrication. The 50-pound commercial CO_2 cylinders that are used to recharge the 15-pound portable cylinders must be weighed at the required intervals and replaced when necessary.

INSTALLED CO_2 SYSTEMS

Carbon dioxide extinguishers are installed in naval ships to provide a dependable and readily available means to flood (or partially flood) certain areas that present unusual fire hazards. An installed CO_2 extinguishing system has one or more 50-pound cylinders. The cylinders may be installed singly or in batteries of two or more. Except for their size and releasing mechanisms, the 50-pound portable cylinders are essentially the same as the 15-pound portable cylinders.

There are two types of installed CO_2 systems—the hose-and-reel installation and the flooding system. The flooding system is used for spaces that are not normally occupied by personnel.

CO_2 Hose-and-Reel System

The CO_2 hose-and-reel installation consists of two cylinders, a length of special CO_2 hose coiled on a reel, and a horn-shaped nonconducting nozzle equipped with a second control valve. When the hose and reel are both installed near the normal access, each of the two cylinders is provided with an individual on-off control.

(See fig. 5-42.) If the cylinders are not located near the hose reel, remote control pull boxes are provided at the hose reel for discharging each cylinder individually (fig. 5-43).

To operate a CO_2 hose-and-reel system, use the following procedure:

1. Make sure that the horn valve is in its CLOSED position.
2. Open the control valve on the cylinder intended for use.
3. Unreel the hose and run the horn to the point of attack on the fire.
4. Open the horn valve by turning the lever or by depressing the squeeze grip.
5. Direct the CO_2 discharge toward the base of the fire, not toward the center of the fire.

CO_2 Flooding System

The CO_2 flooding system (fig. 5-44) consists of one or more cylinders connected by piping from the valve outlets to a manifold. Fixed piping leads from the manifold to various areas of the compartment to be flooded. Cables run from the valve control mechanisms to pull boxes that are located outside the compartment containing the cylinders. The cylinders may also be located outside the compartment to be protected. To release CO_2, just break the glass in the front of the pull box and pull the handle of the cable leading to the CO_2 cylinders.

There are usually one or two valve control devices in a CO_2 flooding system. The number of valve control devices provided will depend on the number of cylinders in the bank. The

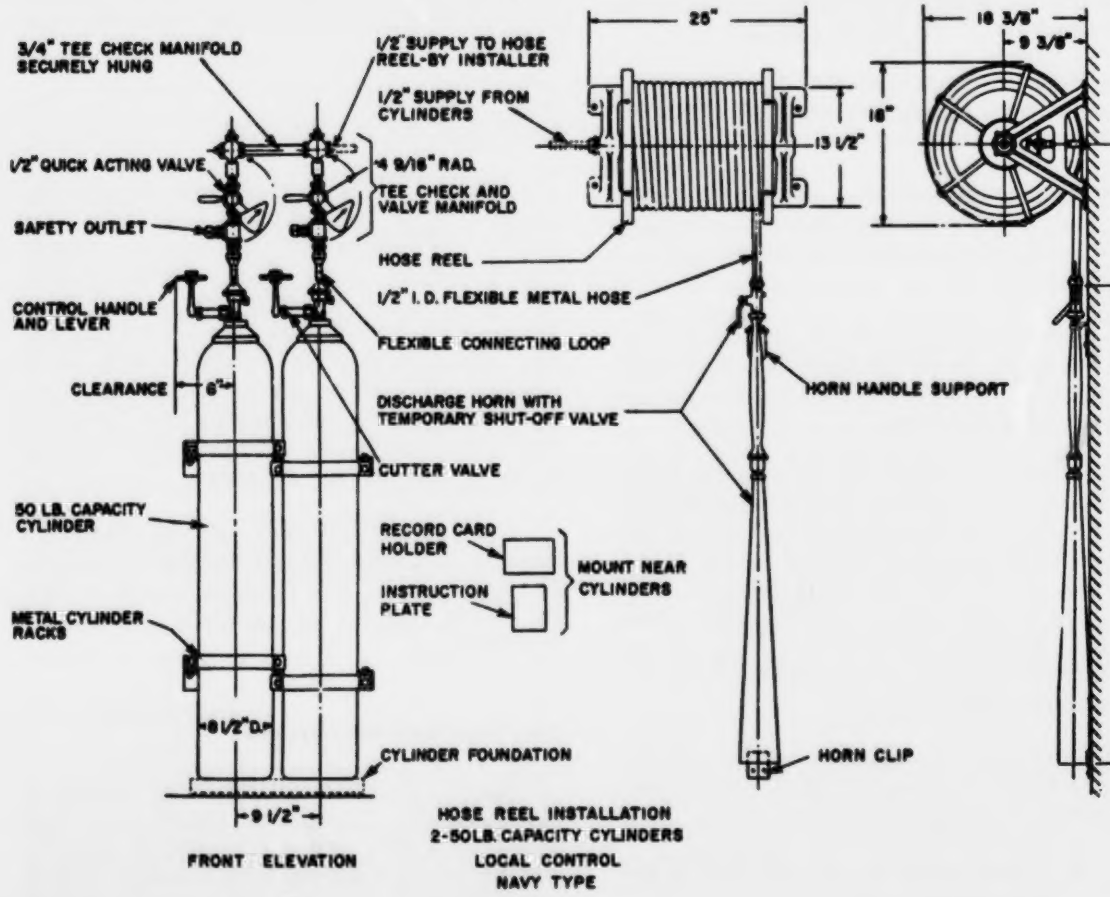

3/4" TEE CHECK MANIFOLD SECURELY HUNG
1/2" SUPPLY TO HOSE REEL-BY INSTALLER
1/2" SUPPLY FROM CYLINDERS
1/2" QUICK ACTING VALVE
4 9/16" RAD.
TEE CHECK AND VALVE MANIFOLD
SAFETY OUTLET
HOSE REEL
1/2" I. D. FLEXIBLE METAL HOSE
CONTROL HANDLE AND LEVER
FLEXIBLE CONNECTING LOOP
CLEARANCE
6"
DISCHARGE HORN WITH TEMPORARY SHUT-OFF VALVE
HORN HANDLE SUPPORT
CUTTER VALVE
50 LB. CAPACITY CYLINDER
RECORD CARD HOLDER
INSTRUCTION PLATE
MOUNT NEAR CYLINDERS
METAL CYLINDER RACKS
8 1/2" D.
CYLINDER FOUNDATION
HORN CLIP
9 1/2"
FRONT ELEVATION
HOSE REEL INSTALLATION
2-50LB. CAPACITY CYLINDERS
LOCAL CONTROL
NAVY TYPE
25"
18 3/8"
9 3/8"
16"
13 1/2"
53"

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Figure 5-42.—Hose-and-reel CO_2 installation with local control at cylinders.

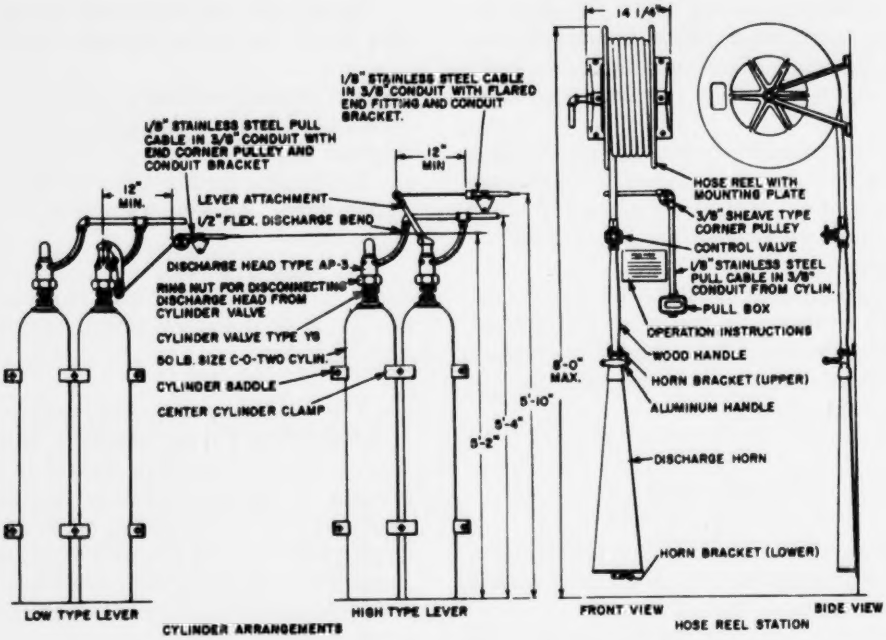
1/8" STAINLESS STEEL CABLE IN 3/8" CONDUIT WITH FLARED END FITTING AND CONDUIT BRACKET.
1/8" STAINLESS STEEL PULL CABLE IN 3/8" CONDUIT WITH END CORNER PULLEY AND CONDUIT BRACKET
12" MIN.
12" MIN
LEVER ATTACHMENT
1/2" FLEX. DISCHARGE BEND
DISCHARGE HEAD TYPE AP-3
RING NUT FOR DISCONNECTING DISCHARGE HEAD FROM CYLINDER VALVE
CYLINDER VALVE TYPE Y8
50 LB. SIZE C-O-TWO CYLIN.
CYLINDER SADDLE
CENTER CYLINDER CLAMP
5'-10"
5'-4"
5'-2"
LOW TYPE LEVER
HIGH TYPE LEVER
CYLINDER ARRANGEMENTS
14 1/4"
8'-0" MAX.
HOSE REEL WITH MOUNTING PLATE
3/8" SHEAVE TYPE CORNER PULLEY
CONTROL VALVE
1/8" STAINLESS STEEL PULL CABLE IN 3/8" CONDUIT FROM CYLIN.
PULL BOX
OPERATION INSTRUCTIONS
WOOD HANDLE
HORN BRACKET (UPPER)
ALUMINUM HANDLE
DISCHARGE HORN
HORN BRACKET (LOWER)
FRONT VIEW
SIDE VIEW
HOSE REEL STATION

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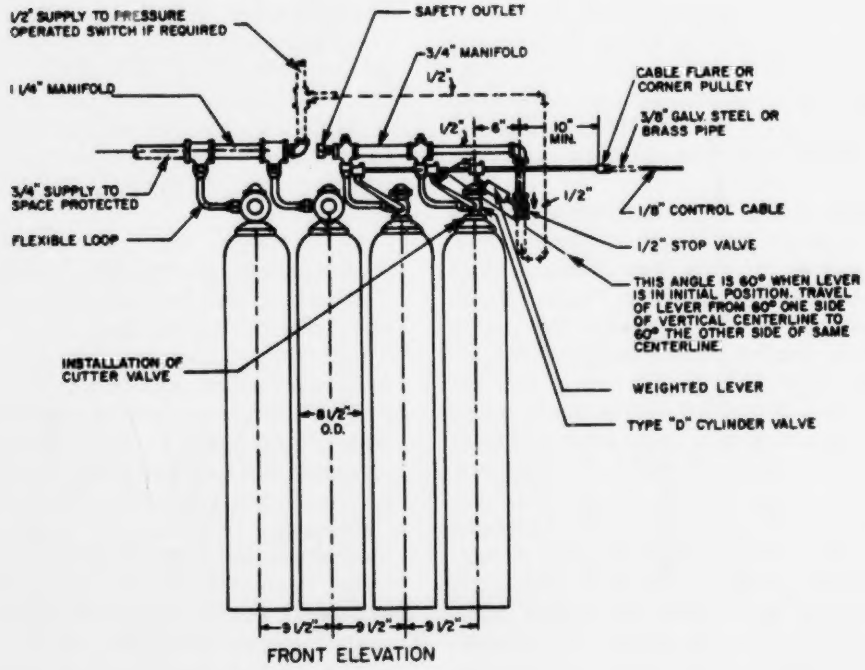
Figure 5-43.—Hose-and-reel CO_2 installation with remote control pull boxes.


1/2" SUPPLY TO PRESSURE OPERATED SWITCH IF REQUIRED
SAFETY OUTLET
3/4" MANIFOLD
1 1/4" MANIFOLD
1/2"
1/2"
6"
10" MIN.
CABLE FLARE OR CORNER PULLEY
3/8" GALV. STEEL OR BRASS PIPE
3/4" SUPPLY TO SPACE PROTECTED
1/2"
1/8" CONTROL CABLE
FLEXIBLE LOOP
1/2" STOP VALVE
THIS ANGLE IS 60° WHEN LEVER IS IN INITIAL POSITION. TRAVEL OF LEVER FROM 60° ONE SIDE OF VERTICAL CENTERLINE TO 60° THE OTHER SIDE OF SAME CENTERLINE.
INSTALLATION OF CUTTER VALVE
WEIGHTED LEVER
TYPE "D" CYLINDER VALVE
8 1/2" O.D.
9 1/2"
9 1/2"
9 1/2"
FRONT ELEVATION

103.93

Figure 5-44.—CO_2 flooding system.

remaining cylinders in the bank (if any) are provided with pressure-actuated discharge heads. These open automatically when pressure from the controlled cylinders enters the discharge head outlet.

The CO_2 installations in naval ships are made by several manufacturers, and they differ in some minor details. For detailed information on a specific installation, consult the manufacturer's technical manual.

Before operating an installed CO_2 system, be sure that all openings in the compartment are closed and that the ventilation system for the space is secured. These precautions are necessary to prevent the loss of CO_2.

HALON 1301

The Halon 1301 system is a relatively new fire-extinguishing system (fig. 5-45) used aboard naval ships. For most fires, a Halon concentration as little as 5 to 7 percent can extinguish a wide variety of flammable liquids and surface-burning solid fuels. It can also control deep-seated fires in flammable solids.

Halon 1301 systems distribute a 5- to 7-percent concentration evenly throughout the space upon complete discharge of the agent. This concentration should be held in the space for a minimum of 10 minutes. Furthermore, this fast-acting, colorless, odorless, electrically nonconductive, heavier-than-air gas is just the thing to use as a last resort against most class A, class B, and class C fires.

In addition, Halon is low in toxicity, does no damage to property, and leaves no mess to clean up. As a matter of fact, the National Fire Protection Association recognizes Halon 1301 as the only gaseous agent acceptable for use in occupied areas. Because of its speed in extinguishing fires, it can even stop fire while you are exiting the space! It has been used in closed spaces for over 30 years without a single reported injury resulting from exposure to its vapor. Furthermore, the heat decomposition products of Halon (for example, hydrogen bromide and hydrogen fluoride create a lesser hazard than the decomposition products from the fire itself, especially carbon monoxide, smoke, heat, and oxygen depletion. In most fire situations where 1301 is used, Halon by-products are often barely detectable by the nose. When the by-products are at harmful toxic levels, you will notice a noxious and irritating odor.

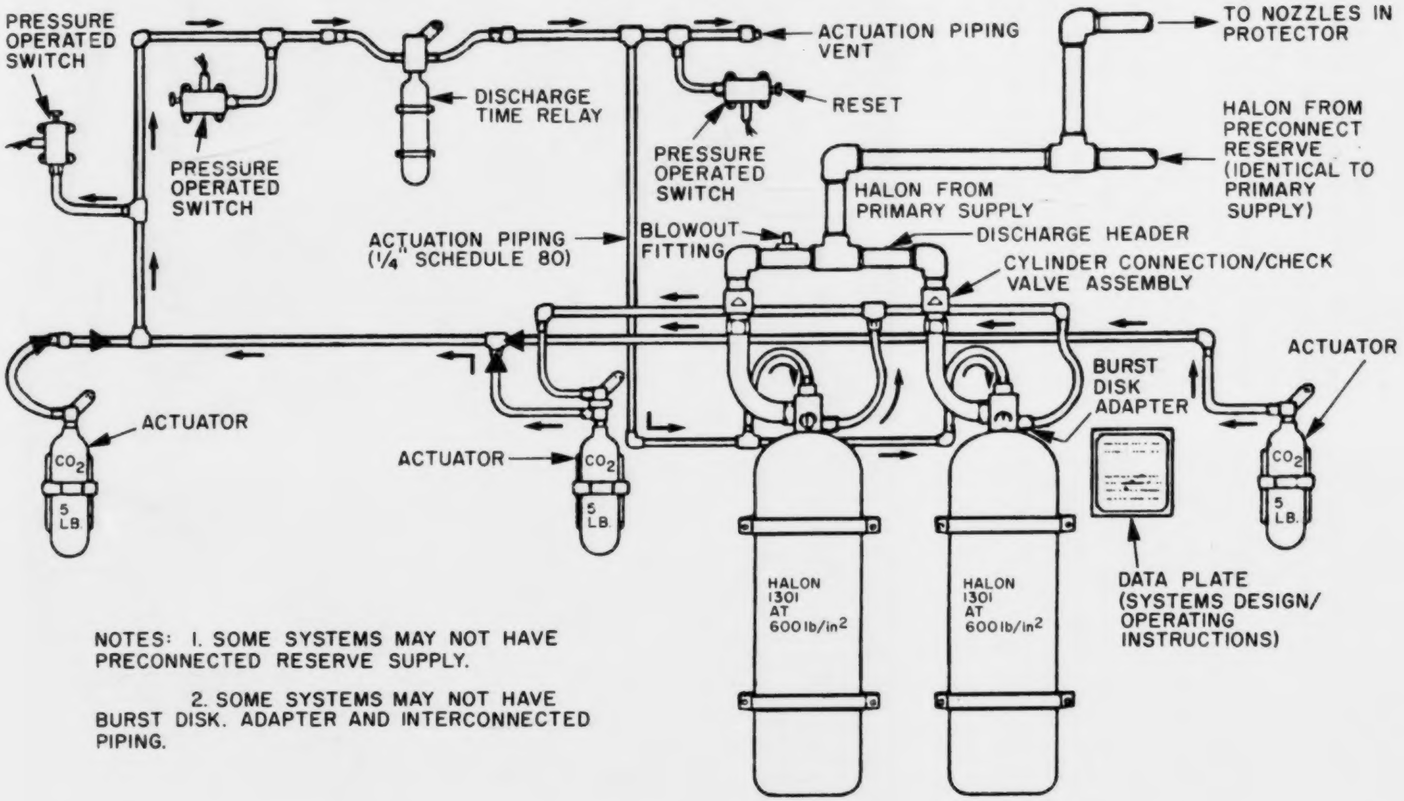
Halon 1301 has NOT been found to be effective on the following burning materials:

1. Certain chemicals or mixtures of chemicals, such as cellulose nitrate and gunpowder, that are capable of rapid oxidation in the absence of air
2. Reactive metals such as sodium, potassium, magnesium, titanium, zirconium, uranium, and plutonium
3. Metal hydrides
4. Chemicals capable of undergoing thermal decomposition, such as certain organic peroxides and hydrazine

The term *Halon* was first used in 1948 by the U.S. Army Corps of Engineers as a convenient means of identification. Halon is a shortened version of halogenated hydrocarbon. The U.S. Army devised a numbering system and, in 1948, chose Halon 1301 as the ideal extinguishing agent. It proved to be safe, fast, and clean. The Navy used Halon 1301 on ships in the early 1970s on a test basis.

The major purpose of Halon is to extinguish disastrous fires in machinery spaces. By 1978, ocean minesweepers (MSOs) and new construction ships were equipped with Halon 1301 systems. Many of the older naval ships have since been equipped with these systems. Halon 1301 complements the total shipboard fire-fighting system. It is used as the final line of defense after other alternatives, such as portable extinguishers and the twin agent system, have been considered. In machinery spaces, Halon 1301 used in conjunction with AFFF is quite effective against class B fires.

The Halon 1301 systems are located in three major types of spaces—machinery spaces, flammable liquid and flammable gas storerooms, and Versatile Avionic Shop Test (VAST) spaces. Three types of systems are available—modular, manifold banked, and central storeroom. Halon in VAST spaces is stored in a spherical container, with piping going to multiple nozzles and an actuation system. Therefore, VAST Halon may be classified as a modular system. Storerooms for flammables typically are equipped with the modular systems. Manifold banked systems are found in most machinery spaces. The major exception to this is the minesweepers. They use a central storeroom Halon setup. In machinery spaces, such as engine rooms or firerooms, you may find Halon 1301 in one or more cylinders piped to discharge nozzles located at the overhead of the space. The discharge nozzles and piping


PRESSURE OPERATED SWITCH
PRESSURE OPERATED SWITCH
DISCHARGE TIME RELAY
ACTUATION PIPING VENT
RESET
PRESSURE OPERATED SWITCH
TO NOZZLES IN PROTECTOR
HALON FROM PRECONNECT RESERVE (IDENTICAL TO PRIMARY SUPPLY)
HALON FROM PRIMARY SUPPLY
ACTUATION PIPING (1/4" SCHEDULE 80)
BLOWOUT FITTING
DISCHARGE HEADER
CYLINDER CONNECTION/CHECK VALVE ASSEMBLY
ACTUATOR
BURST DISK ADAPTER
ACTUATOR
ACTUATOR
CO2
5 LB.
CO2
5 LB.
CO2
5 LB.
HALON 1301 AT 600 lb/in2
HALON 1301 AT 600 lb/in2
DATA PLATE (SYSTEMS DESIGN/ OPERATING INSTRUCTIONS)

NOTES: 1. SOME SYSTEMS MAY NOT HAVE PRECONNECTED RESERVE SUPPLY.

2. SOME SYSTEMS MAY NOT HAVE BURST DISK. ADAPTER AND INTERCONNECTED PIPING.

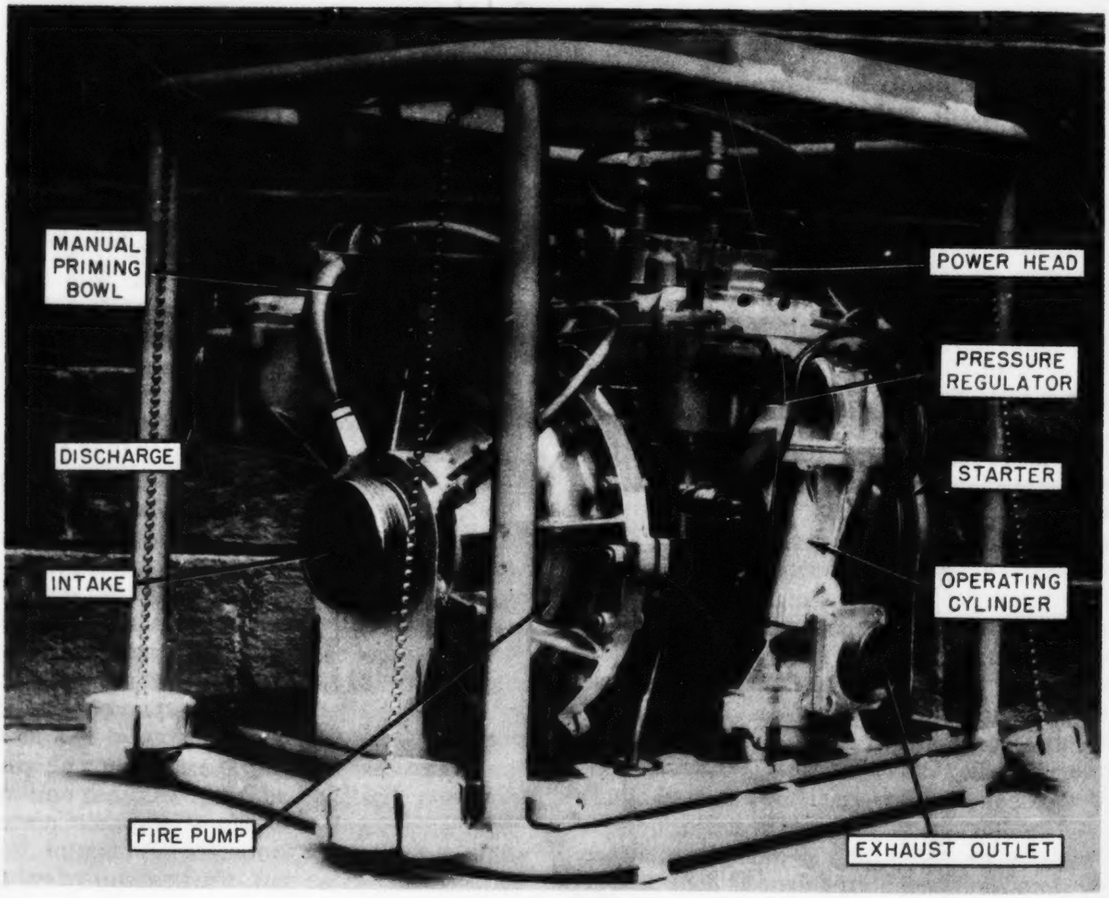
8.497

Figure 5-45.—Typical Halon System.

take on different configurations, depending on what type of Halon system is installed.

The type of Halon system you are likely to encounter varies according to the type of ship. Regardless of the type or location, all Halon is stored in liquid form in nonshatterable steel storage cylinders. With the help of super pressurized nitrogen, the Halon is expelled as a gas. In machinery spaces, Halon cylinders are super pressurized with nitrogen to 600 psi at 70 °F. Nitrogen acts as a booster, ensuring rapid and complete discharge of all the extinguishing agent. If Halon in one of the cylinders exceeds 240 °F (or 2,650 psi to 3,000 psi at 70 °F), the rupture disk will break. This is a built-in safety feature that prevents cylinders from exploding.

Manually operated Halon systems may be lit-off with either local or remote pneumatic actuators (small CO_2 cylinders). These CO_2 cylinders also have a rupture disk feature. Their bursting range is also between 2,650 psi and 3,000 psi at 70 °F. Actuation is triggered from within the space or outside and next to each main access to the space. Actuation stations for machinery spaces are located inside each main machinery space, fireroom, and engine room. Stations are also located at the outside entrance to each main access trunk on the damage control deck. Other safety features of the system include automatic ventilation shutdown, actuation of local and remote predischarge alarms (such as a red rotary beacon light and a loud horn), a 60-second discharge time delay, and a discharge alarm.



3.164

Figure 5-46.—P-250 pump.

WARNING

Do not reenter the space where Halon has been used to extinguish a fire unless you are wearing an oxygen breathing apparatus (OBA). Wear the OBA until the atmosphere is certified safe. Anyone suffering from the toxic effects of Halon 1301 vapor should immediately move, or be moved, to fresh air.

A soaking period of at least 15 minutes is required to ensure that the space has cooled and the fire will not reflash upon reentry of personnel. Oxygen that is let into the space when a hatch is opened or the ventilation system is restarted will dilute the concentration while the fuel is at or above ignition temperature.

Halon, however, is far from perfect. Battle damage or other events allowing air into the space can result in loss of Halon from the space. There is no cooling effect associated with Halon. Therefore, as long as hot surfaces or smoldering materials are present, reflash is possible. Another limitation is that Halon cannot be replenished during operation. Boiler fire extinguishment poses a danger of flashback or explosion within the boiler. Finally, the presence of Halon decomposition products adds to the already dangerous toxic substances in the space, even though the danger from the Halon itself is minimal.

Halon 1301 systems are the only systems that combine effective fire control with personnel safety. Also, Halon 1301 has the lowest toxicity levels of all the Halons currently in use. Very little of the agent is needed to put out most fires. When properly used, it is safe.

P-250 PUMPS

The P-250 pump that has been in service for some years is being replaced by the P-250, Mod 1. Both pumps are discussed below.

P-250 PORTABLE PUMP

The P-250 is a gasoline-driven portable pump with an internal-combustion engine. It is used in fire fighting and in dewatering operations. When used for fire fighting, the P-250 draws water from the sea and pumps the water through suitable hoses and nozzles at a high pressure. When used for dewatering, the P-250 draws a large volume of water from flooded compartments and discharges it into the sea. The P-250 has the capacity to pump 250 gallons of water per minute. The pump is self-priming up to a suction lift of 16 to 20 feet. Figures 5-46 and 5-47 show two different views of the P-250.

Before operating the P-250 portable pump, make sure that all of the suction hose connections between the foot valve and the pump are tight. Be sure that proper-size gaskets are used at all of the suction connections. The strainer should be completely submerged in water. If the pump fails to draw water or if the discharge nozzle shows an uneven stream, the probable cause is a poor connection allowing air leakage into the suction side. The suction screen should rest in clear water—not in mud or debris, which might be drawn into the pump. The suction hose should be supported. The foot valve should be completely submerged when the pump is operating. Otherwise, severe damage could result. The pump must not be operated in a confined space unless the exhaust hose is connected to the pump. The exhaust hose carries the toxic engine exhaust gases to the atmosphere. The gas tank is a 6-gallon tank and is identical to the tanks used for the outboard motors on small pleasure boats.

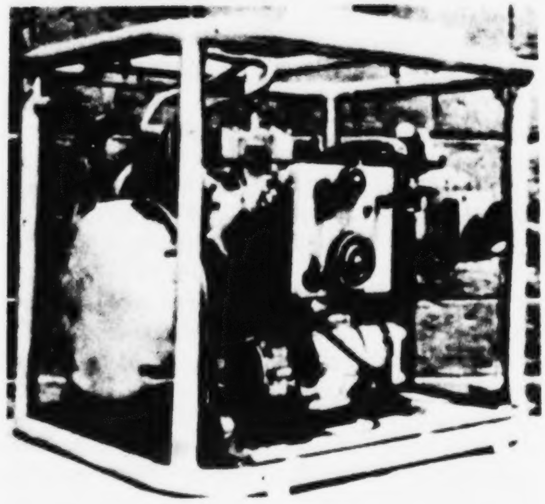


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Figure 5-47.—P-250 pump, showing control panel.

To operate the P-250 pump, proceed as follows:

CAUTION

> Do NOT run the pump more than 45 seconds unless pressure shows on the gauge. If the pump is not primed in 45 seconds, stop the engine, tighten all suction connections and hose couplings, and try priming again. If the pump is operated more than 15 to 20 seconds with the outlet valve in the CLOSED position, the pump may begin to cavitate and speed up as result of the accumulation of air in the impeller housing. Open the water outlet valve momentarily to allow the trapped air to escape.

1. Make the required suction and discharge connections.
2. Fill the gasoline tank with a mixture consisting of one-half pint of the specified engine oil to each gallon of gasoline. Mix the oil and the gasoline thoroughly.
3. Clamp the fuel tank to the top of the frame, using the clamps provided for this purpose.
4. Connect the hose assembly from the fuel tank to the plug provided on the control panel.
5. Pump fuel to the carburetor by pressing the push button on the tank several times, until you feel some resistance. At this point, stop pressing IMMEDIATELY. If you continue to press the push button after you have once felt resistance, you could damage the diaphragm.
6. Place the water outlet valve in the CLOSED position. Be sure that the wing nut on the manual priming filler bowl is tight.
7. Pull the choke knob to the extended position. Turn the HIGH- and the LOW-speed knobs on the control panel three-quarters of a turn to the left from the CLOSED position.
8. Pull the starting cord rapidly, but do not jerk the cord. After the engine starts and runs for a few seconds, push the choke knob in toward the control panel. The starter cord will automatically rewind.
9. Check the pressure gauge to make sure that water pressure is building up. This should occur 20 seconds after the pump has been started, at a suction lift of 16 feet.
10. When pressure shows on the gauge, open the outlet valve slowly and allow water to enter the discharge hose.
11. Adjust the carburetor HIGH-speed dial to the best operating position. For slow speed adjustment, slow the engine to IDLE by partially closing the throttle with the stop button.
12. Adjust the water discharge pressure by turning the pressure regulator to the desired setting. Use a screwdriver to make this adjustment.
13. While the engine is running, check the water pressure to be sure that it remains at the desired level.

If you have to restart a P-250 while the engine is still warm from previous use, pull the starter cord. No choking should be necessary. However, use the choke if the engine does not start immediately. Be careful to avoid flooding the engine. If the engine does flood, close the needle valves and crank the engine until it starts. Then set the HIGH- and LOW-speed knobs to the previously set positions.

After the P-250 pump has been operated and then shut down, it should be prepared for temporary stowage as follows:

1. Remove the fuel tank from the frame and disconnect the pump. Release the tank pressure by loosening the filler cap. Retighten the cap.
2. Disconnect the suction, exhaust, discharge, and drain hoses.
3. Drain the pump and pump head by inverting the entire unit so that the flywheel end is up. Tilt the unit back and forth until all water has been drained. Repeat this operation several times, each time returning the unit to its normal position for about 10 seconds; this allows more water to drain from the power head to the impeller housing.
4. Flush the pump by pouring clean freshwater, if available, into the impeller housing through the manual priming bowl. Drain the impeller housing.
5. Replace the thread protectors on all openings, and clean and dry the entire unit.

P-250 MOD 1 PORTABLE PUMP

The P-250 Mod 1 is a gasoline-driven portable pump with an internal-combustion engine. It is used in fire fighting and in dewatering operations. When used for fire fighting, the P-250 Mod 1 draws water from the sea and pumps the water through suitable hoses and nozzles at a high pressure. When used for dewatering, it draws a large volume of water from flooded compartments and discharges it into the sea. The P-250 Mod 1 can pump 250 gpm at 125 psig. It is hand primed up to a suction lift of 16 to 20 feet.

Before operating the P-250 Mod 1, make sure that all of the suction hose connections between the foot valve and the pump are tight. Be sure that proper-size gaskets are used at all of the suction connections. The strainer should be completely submerged in water. If the pump fails to draw water or if the discharge nozzle shows and uneven stream, look for a poor connection allowing air leakage into the suction side. The suction screen should rest in clear water—not in mud or debris, which might be drawn into the pump. The suction hose should be supported. The foot valve should be completely submerged when the pump is operating. Otherwise, severe damage could result. The pump must not be operated in a confined space unless the exhaust hose is connected to the pump. The exhaust hose carries the toxic engine exhaust gases to the atmosphere. The gas tank is a 6-gallon tank mounted on top of the pump frame. The tank consist of a single hose fitting, a fuel tank cap with an integral fuel gauge, a manually operated vent screw, and an explosion suppression arrangement (Explosafe).

Operate the P-250 Mod 1 pump as follows:

WARNING

> Do NOT run the pump more than 20 seconds unless pressure shows on the gauge. If pressure does not show on the pressure gauge, stop the pump and check all suction hose connections and gaskets. Then prime and restart. If the pump is operated for more than 15 to 20 seconds with the discharge valve closed, it may begin to cavitate and speed up due to accumulation of air in the casing. Open the discharge valve momentarily to allow trapped air to escape.

1. Connect hoses to suction, discharge, and exhaust connections.
2. Close the pump discharge valve and make certain that the tee-handle screw on the rapid priming port is tight.
3. Check the fluid levels in the fuel tank and oil tank. Fill as necessary.
4. Attach the fuel tank to the top of the pump frame. Connect the fuel hose to the fuel tank and open the vent on the fuel tank cap.
5. Prime the fuel/oil injection pump by compressing the fuel and oil priming bulbs until they are firm.
6. Pull the engine carburetor primer two to three times to prime the carburetor.
7. Prime the pump by operating the manual priming pump until water is discharged out of the priming pump discharge.
8. Set the throttle lever and START/RUN switch to the START position.
9. Pull the manual starter handle and switch to the RUN position.
10. Adjust the engine throttle lever and open discharge valve slowly to obtain the desired pump discharge pressure.
11. While the engine is running, occasionally check the discharge to ensure it remains at the desired pressure.
12. To stop the unit, gradually return the throttle lever to the start position. Press the STOP button on the control panel, and keep it depressed until the engine comes to a complete stop.

If the engine is still warm from previous operation, the start-up procedure will be modified. Simply shift the START/RUN switch to the START position and pull the manual starter handle. Priming should not be necessary. If the engine does not start immediately, prime the carburetor and crank the engine until it starts. Upon completion of the pump operation, always prepare the pump for temporary storage in the following manner.

1. Flush the pump by operating the unit in freshwater for 5 minutes.
2. Slow the engine speed and move the throttle lever to the START position.
3. Close the discharge valve.
4. Stop the engine by disconnecting the fuel hose. Allow the engine to run until fuel is burned out of the carburetors.
5. Remove the fuel tank.
6. Disconnect the suction, discharge, and exhaust hoses.
7. Allow the water to drain from the pump casing.
8. Grease the pump wear rings.
9. Replace the thread protectors on all connections; clean and dry the entire unit.
10. Operate the once each month while it is in temporary stowage.

You can find additional information on the operation and maintenance of the P-250 pump and P-250 MOD 1 in chapter 9930 of the *Naval Ships' Technical Manual* and in the manufacturer's technical manual furnished with the pump.

GAS CYLINDERS AND CYLINDER VALVES

You need to know the standard Navy system for marking gas cylinders, and to be able to identify the cylinder valves and cylinders of various gases. You should be familiar with the construction, design, and size of these cylinders. You should also know how to handle and stow gas cylinders in a safe and proper manner. This chapter will give you a few of the important facts about gas cylinders and cylinder valves. Additional information concerning compressed gases can be found in MIL-STD-101B, Change 2, December 1970, *Color Codes for Pipelines and for Compressed Gas Cylinders*.

CONSTRUCTION OF CYLINDERS

Gas cylinders are made of high-quality steel. High-pressure gases, such as oxygen, hydrogen, nitrogen, and compressed air are stored in cylinders of seamless construction. Only non-shatterable high-pressure gas cylinders may be used by ships or activities operating outside the continental United States. Cylinders for low-pressure gases, such as acetylene, may be welded or brazed. All cylinders are carefully tested, either at the factory or a designated processing station, at pressures above the maximum permissible charging pressure.

The cylinders for most compressed gases are shaped alike. However, cylinders for acetylene are shorter and of a larger diameter, as shown in figure 5-48.

All gas cylinders have safety devices either in the valve, in the shoulder, in the bottom of the cylinder, or in a combination of these places. A

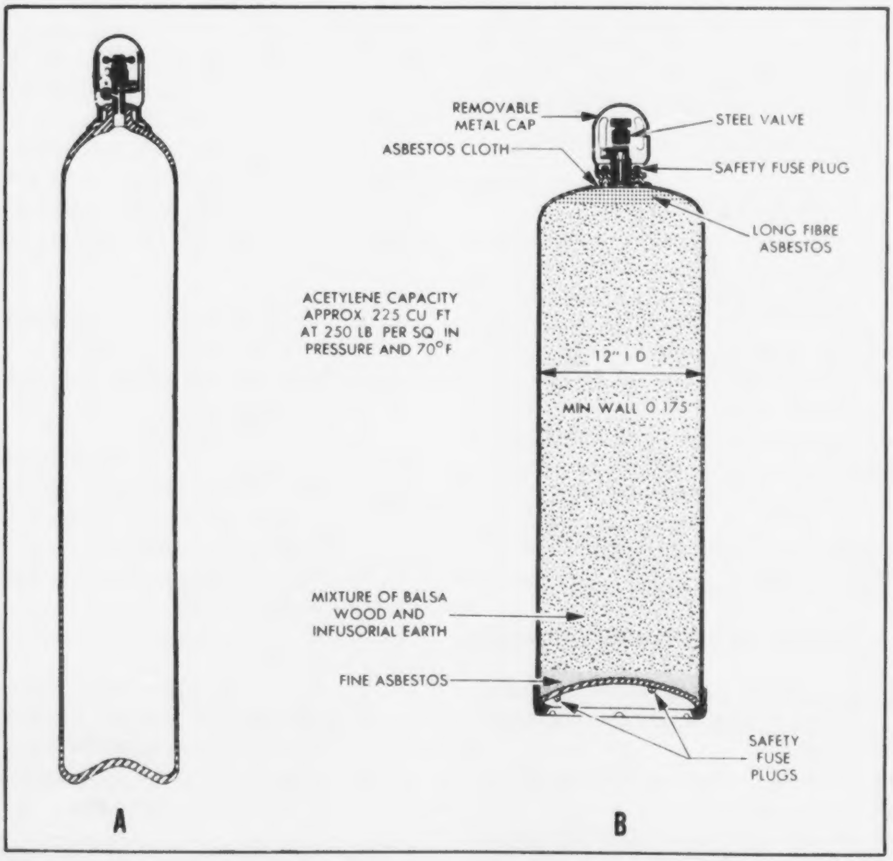
REMOVABLE METAL CAP
STEEL VALVE
ASBESTOS CLOTH
SAFETY FUSE PLUG
LONG FIBRE ASBESTOS
ACETYLENE CAPACITY APPROX. 225 CU FT AT 250 LB PER SQ IN PRESSURE AND 70°F
12" I D
MIN. WALL 0.175"
MIXTURE OF BALSA WOOD AND INFUSORIAL EARTH
FINE ASBESTOS
SAFETY FUSE PLUGS
A
B

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Figure 5-48.—Cutaway view of compressed gas cylinder: (A) oxygen cylinder; (B) acetylene cylinder.

threaded valve protection cap screws on the neck ring and protects the valve.

MARKING AND IDENTIFYING GAS CYLINDERS

Gas cylinders are manufactured and maintained in accordance with the regulations of the Interstate Commerce Commission (ICC). The ICC stipulates that each cylinder be indented or stenciled with prescribed identification markings. Cylinders larger than 2 inches in diameter must be indented with serial numbers. Therefore, cylinders exceeding 2 inches in diameter, which are not assigned Navy serial numbers, require manufacturer's serial numbers. No more than 500 cylinders are allowed in each lot manufactured. Requirements for ICC 8 (acetylene) and ICC 9 (aerosol dispenser) cylinders are exceptions to this requirement. ICC 8 cylinders of all sizes require serial numbers and ICC 9 cylinders of all sizes are assigned lot numbers. However, an unlimited number per lot is authorized.

Navy-owned compressed-gas cylinders are indented with figures and letters as shown in table 5-1.

Table 5-1.—Cylinder Markings

Markings on one side of cylinder	Examples
ICC mark and "SPUN" when spun cylinders are so manufactured.	Oxygen cylinder—ICC 3A—1800—SPUN. Acetylene cylinder—ICC 8.
Manufacturer's symbol—Navy serial number—letter and "NONSHAT" if cylinder is the nonshatterable type.	Oxygen cylinder—MFG—$\overset{U}{\underset{N}{S}}X50789\overset{U}{\underset{N}{S}}$—NONSHAT. Acetylene cylinder—MFG—$\overset{U}{\underset{N}{S}}A45678\overset{U}{\underset{N}{S}}$.
Third party inspection mark and Navy inspector's stamp	(INSP) Symbol. (NAVY) (INSP) Symbol.
Markings on the other side of cylinder	**Examples**
Navy specification number and date (month and year)	Oxygen, 51C31—10/59 D, Acetylene, 51C30—10/59.
Tare weight of cylinder in pounds (when required)	115.6 pounds or as appropriate.
Original and subsequent test dates months and year	10/59 or as appropriate.

EXPLANATORY NOTES FOR ABOVE TABLE:

1. ICC followed by 3A, 4B, 8, etc., indicates governing ICC specification.
2. ICC 3A or 4B, etc., followed by 1800, 2015, etc., indicates maximum charging pressure at normal temperature (68°-70°F).
3. SPUN—If present, indicates method of manufacturing cylinders. Other cylinders are usually deep drawn and die formed.
4. MFG—to indicate where manufacturer's symbol should be located.
5. MFG followed by $\overset{U}{\underset{N}{S}}A$, $\overset{U}{\underset{N}{S}}X$, $\overset{U}{\underset{N}{S}}S$, etc., and subsequent numbers.
   Subsequent numbers are Navy serial numbers.
6. Nonshat indicates cylinder is manufactured in accordance with Navy specifications for nonshatterable cylinders (under ballistic attack). Ships should stock only nonshatterable cylinders.
7. Tare weight indicates weight of cylinder and valve—does not usually include cap.
8. Exact placement of figures and letters may vary—depending on size and type of cylinder.

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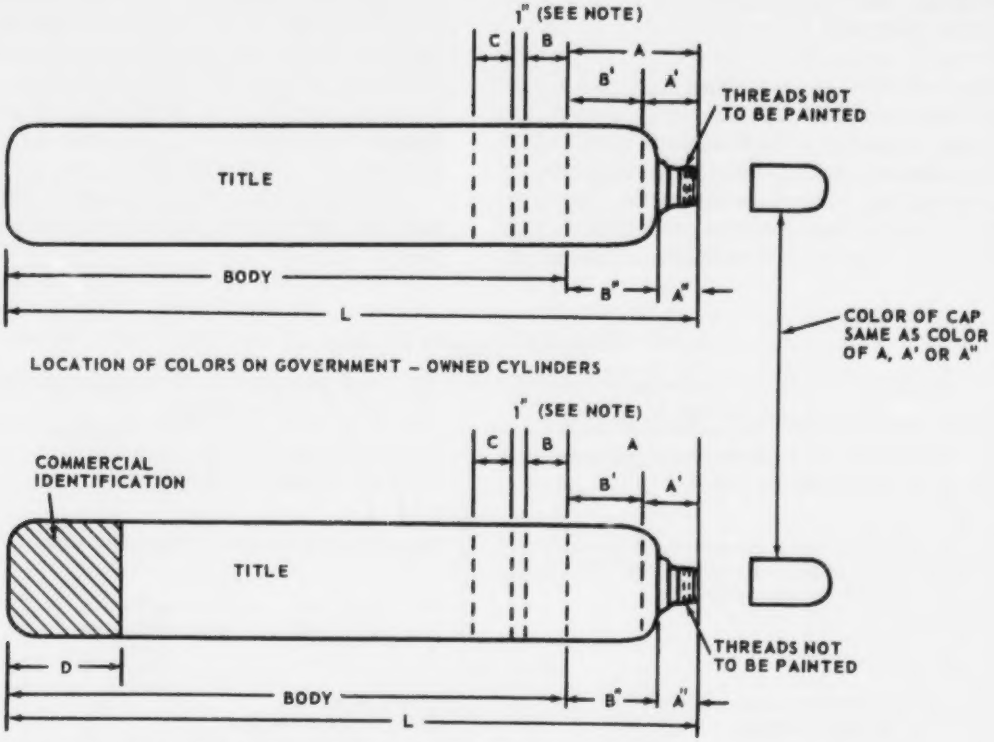
1" (SEE NOTE)
C
B
A
B'
A'
THREADS NOT TO BE PAINTED
TITLE
BODY
B"
A"
L
COLOR OF CAP SAME AS COLOR OF A, A' OR A"
COMMERCIAL IDENTIFICATION
D

LOCATION OF COLORS ON GOVERNMENT - OWNED CYLINDERS

LOCATION OF COLORS ON COMMERCIAL - OWNED CYLINDERS

LOCATION DIMENSIONS

ON CYLINDERS FOR MEDICAL GAS MIXTURES, 1" SPACE AND BAND C ARE LOCATED IMMEDIATELY BELOW BANDS B' OR B"

CYLINDERS FOR	OVERALL LENGTH	SHOULDER COLOR(S)			CYLINDER COLOR BAND (S)				COMMERCIAL IDENTIFICATION
		A	A'	A"	B	B'	B"	C	D
MEDICAL GAS MIXTURE	OVER 30"	L/5	3½"	—	—	A LESS 3½"	—	3"	L/6
OTHER GASES	"	L/5	—	—	3	—	—	3"	L/6
MEDICAL GAS MIXTURE	30" AND UNDER	L/5	—		—	—	A LESS A"	2"	L/6
OTHER GASES	"	L/5	—	—	2	—	—	2"	L/6

FROM CYLINDER TOP TO BOTTOM OF NECK RING

NOTE : 1" SPACE TO BE OMITTED IF BANDS B & C ARE OF DIFFERENT COLORS

102.24

Figure 5-49.—Location of color codes on gas cylinders.

In addition to the identifications required by ICC regulations, Navy-owned cylinders for gases in the liquid state with a water capacity in excess of 15 pounds, or gases in the gaseous state with a volume in excess of 658 cubic inches, are identified by an indented Navy serial number. This number is preceded and followed by the letters *USN*. Acetylene cylinders contain acetylene dissolved in acetone, and are assigned Navy serial numbers on the volume basis. In other words, gases in the liquid state are measured by weight, and those in the gaseous state are measured by volume. Acetylene, though dissolved in a liquid, is measured as a gas by volume.

Since 1 August 1944, Navy serial numbers have had a designated letter placed before the numerals. This letter shows the type of gas carried in the cylinder. The lettering system assigns the following letters to the gases shown below:

A	Acetylene
M	Ammonia
D	Carbon dioxide
K	Chlorine
E	Ethylene oxide
H	Helium
N	Nitrogen
J	Nitrous oxide
G	Aerosol
X	Oxygen
P	Liquefied petroleum gas (propane, butane, etc.)
S	Sulfur dioxide
F	Freon
B	Carboxide
Y	Hydrogen
R	Methyl chloride
Z	Compressed Air
L	Ethyl chloride
NO	Nitrogen dioxide
V	Argon

NOTE: Cylinders without the gas-indicating letters (manufactured prior to 1 August 1944) are still approved for naval service. A list of the identifying serial numbers of these cylinders may be obtained from the Naval Sea Systems Command.

In addition to markings required by the ICC, gas cylinders used by all three services—Navy, Army, and Air Force—have certain standard identifying features. So much injury and damage can be, and has been, caused by mistaking one gas cylinder for another. Therefore, a national program has been established to make it almost impossible to confuse cylinders. The identifying features used by the U.S. Armed Forces in this program consist of using a color code for painting the cylinders, stenciling the name of the gas along two sides of the cylinder, and placing two identifying symbols (decals) on the shoulder of each cylinder. The gas cylinders must be painted as shown in figure 5-49, and the arrangement of colors will appear as shown in table 5-2.

If the color of the cylinders reduces the effectiveness of the ship's camouflage scheme, canvas covers painted with the camouflage colors should be placed over the cylinders. Do not paint the cylinders with camouflage paint.

Shatterproof cylinders are stenciled in two locations with the phrase Non-Shat lengthwise and 90° from the titles. Letters must be either black or white and approximately 1 inch in size.

Color Codes for Cylinders

Color coding is mandatory for compressed-gas cylinders. Identifying colors are assigned by the Standardization Division, Office of the Assistant Secretary of Defense (Supply and Logistics). Cylinders that have a background color of yellow, orange, or buff have the title stenciled in black. Cylinders that have a background color of red, brown, black, blue, gray, or green

Table 5-2.—Cylinder Color Code

Contents of cylinder	Location of cylinder markings*			
	Top A	B and B	B and C	Body
Medical anesthetic gases:				
Cyclopropane	Orange	Yellow	Blue	Blue
Ethylene	Yellow	Blue	do.	do.
Nitrous oxide	Blue	do.	do.	do.
Fuel gases:				
Acetylene	Yellow	Yellow	Yellow	Yellow
Hydrogen	do	Black	do.	do.
Manufactured gases	Brown	Yellow	do.	do.
Petroleum (liquefied & nonliquefied)	Yellow	Orange	do.	do.
Industrial gases:				
Butadiene	Yellow	White	Buff (tan)	Buff (tan)
Ethylene oxide	do.	Blue	do.	do.
Ethyl chloride	Buff	do.	Yellow	do.
Propylene	Yellow	Gray	Buff	do.
Vinyl chloride	do.	Orange	do.	do.
Vinyl methyl ether	do.	Black	do.	do.
Aerosol insecticide	Buff	Buff	do.	do.
Toxics and poisonous materials:				
Carbon monoxide	Yellow	Brown	Brown	Brown
Hydrogen sulfide	Brown	Yellow	do.	do.
Methyl bromide	do.	Black	do.	do.
Boron trifluoride	Gray	Brown	do.	do.
Chlorine	Brown	do.	do.	do.
Hydrogen chloride	do.	White	do.	do.
Phosgene	do.	Orange	do.	do.
Sulfur dioxide	do.	Gray	do.	do.
Refrigerants:				
Ammonia	do.	Yellow	Orange	Orange
Freons	Orange	Orange	do.	do.
Methyl chloride	Yellow	Brown	do.	do.
Oxidizing gases:				
Oxygen, aviator's	Green	White	Green	Green
Air, oil pumped	Black	Green	do.	Black
Air, water pumped	do.	do.	Black	do.
Helium-Oxygen	Buff	White	Green	Green
Oxygen-Carbon dioxide	Gray	do.	do.	do.
Inert gases:				
Argon, oil pumped	do.	do.	White	Gray
Argon, water pumped	do.	do.	Gray	do.
Carbon dioxide	do.	Gray	do.	do.
Helium, oil pumped	do.	Orange	do.	do.
Helium, oil free	Buff	Gray	do.	do.
Nitrogen, oil pumped	Gray	Black	Gray	do.
Nitrogen, water pumped	do.	do.	Black	do.
Fire fighting gases:				
Carbon dioxide	Red	Red	Red	Red
Methyl bromide	do.	Brown	do.	do.

*See fig. 5-49 for location of cylinder markings.

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have the title stenciled in white. Figure 5-50 shows how cylinders are identified by the overall painted color code and by the stenciled name of the gas.

Decalcomanias

As a further identification measure, two decalcomanias (pronounced de-kel-ko-main-e-ah, or abbreviated as decals), are applied to the shoulder of each cylinder. The decals (fig. 5-51) show the name of the gas and the precautions for its handling and use. The decals are available from general stores for each gas used in the Navy.

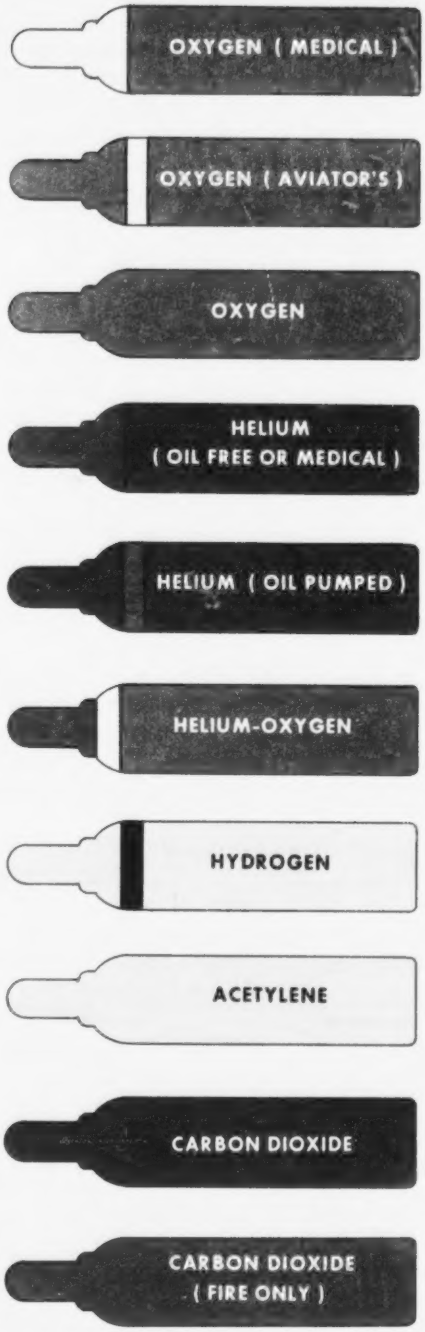
TESTING AND REPAIRING CYLINDERS

ICC regulations require that all gas cylinders, except acetylene cylinders, be retested every 5 years. Cylinders which are due for retesting are not to be charged and shipped until such retests have been properly made. However, cylinders which have been charged before the expiration of their retest period may be shipped and used until empty. They will then be turned in for retesting. The dates of retests are permanently and plainly marked by the stamping on the shoulder of the cylinder, directly opposite the ICC and Navy serial numbers. The stamping, for example 4-58, means that the last test was performed in April 1958.

The 5-year tests are performed by naval activities and civilian agencies under regulations of the ICC. Personnel aboard naval ships are not authorized to perform such tests. Empty cylinders with expired test periods should be returned to the nearest naval supply depot or cylinder testing activity, and marked For Retest.

The naval shipyards at Norfolk, Mare Island, Puget Sound, Charleston, Pearl Harbor, and San Francisco are authorized to conduct 5-year tests.

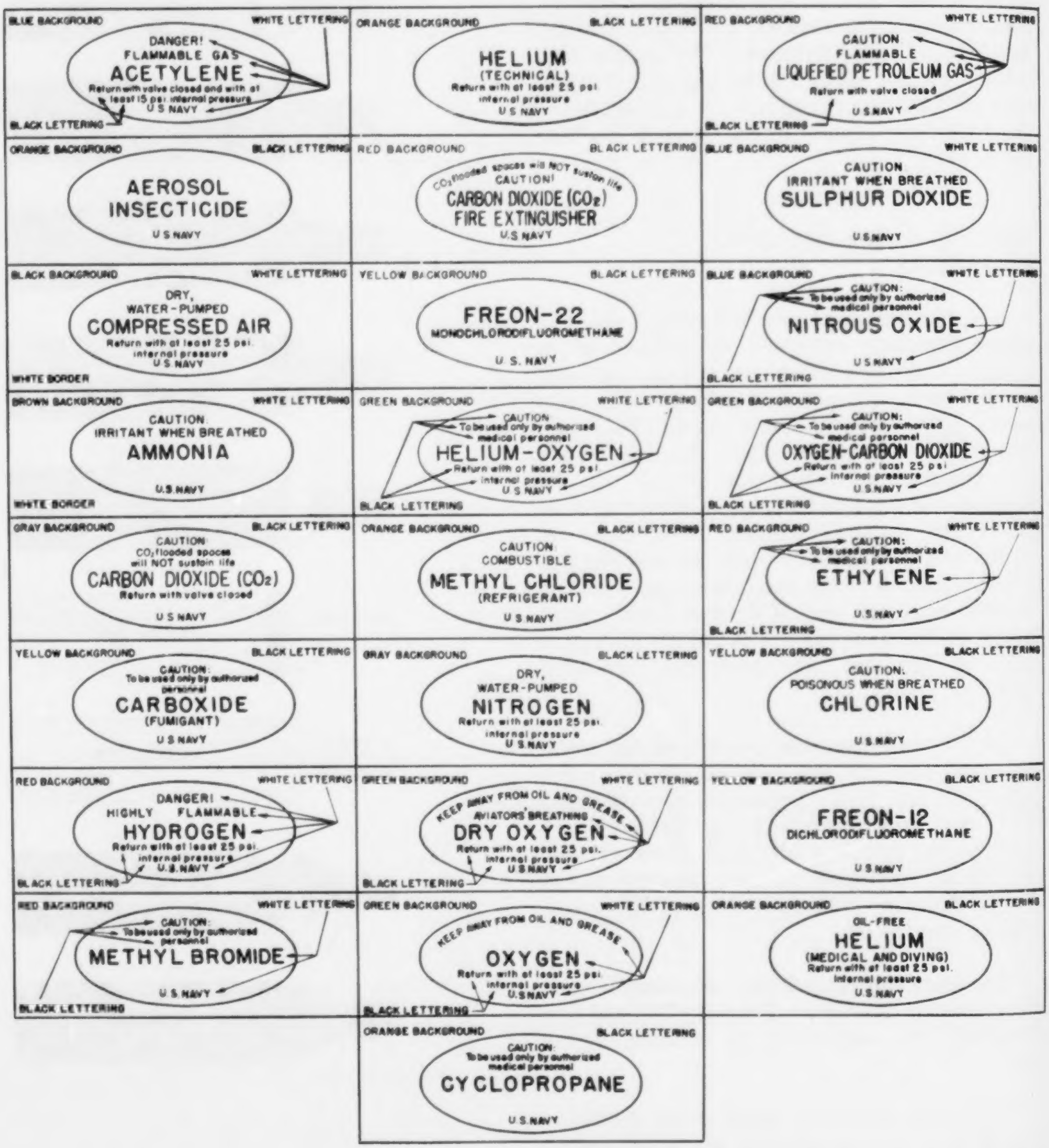
The naval operating bases at the Marianas Islands and Guantanamo Bay are authorized to conduct the 5-year test, but only on CO_2 cylinders.



C54.9

Figure 5-50.—Identifying color patterns for gas cylinders.

Cylinders may be repaired only by ships authorized to perform such work. All cylinders used aboard ship must be in satisfactory and serviceable condition. Therefore, periodic inspections are to be made in accordance with the planned maintenance system. Defective cylinders should have their pressure bled-off. The cylinders should then be sent to the nearest naval supply depot in exchange for good cylinders. The following marks


BLUE BACKGROUND
WHITE LETTERING
DANGER!
FLAMMABLE GAS
ACETYLENE
Return with valve closed and with at least 15 psi internal pressure
U S NAVY
BLACK LETTERING
ORANGE BACKGROUND
BLACK LETTERING
HELIUM
(TECHNICAL)
Return with at least 25 psi internal pressure
U S NAVY
RED BACKGROUND
WHITE LETTERING
CAUTION
FLAMMABLE
LIQUEFIED PETROLEUM GAS
Return with valve closed
U S NAVY
BLACK LETTERING
ORANGE BACKGROUND
BLACK LETTERING
AEROSOL
INSECTICIDE
U S NAVY
RED BACKGROUND
BLACK LETTERING
CO₂ flooded spaces will NOT sustain life
CAUTION!
CARBON DIOXIDE (CO₂)
FIRE EXTINGUISHER
U.S NAVY
BLUE BACKGROUND
WHITE LETTERING
CAUTION
IRRITANT WHEN BREATHED
SULPHUR DIOXIDE
U S NAVY
BLACK BACKGROUND
WHITE LETTERING
DRY,
WATER-PUMPED
COMPRESSED AIR
Return with at least 25 psi.
internal pressure
U S NAVY
WHITE BORDER
YELLOW BACKGROUND
BLACK LETTERING
FREON-22
MONOCHLORODIFLUOROMETHANE
U. S. NAVY
BLUE BACKGROUND
WHITE LETTERING
CAUTION:
To be used only by authorized medical personnel
NITROUS OXIDE
U S NAVY
BLACK LETTERING
BROWN BACKGROUND
WHITE LETTERING
CAUTION:
IRRITANT WHEN BREATHED
AMMONIA
U.S NAVY
WHITE BORDER
GREEN BACKGROUND
WHITE LETTERING
CAUTION
To be used only by authorized medical personnel
HELIUM-OXYGEN
Return with at least 25 psi
internal pressure
U S NAVY
BLACK LETTERING
GREEN BACKGROUND
WHITE LETTERING
CAUTION:
To be used only by authorized medical personnel
OXYGEN-CARBON DIOXIDE
Return with at least 25 psi
internal pressure
U S NAVY
BLACK LETTERING
GRAY BACKGROUND
BLACK LETTERING
CAUTION:
CO₂ flooded spaces will NOT sustain life
CARBON DIOXIDE (CO₂)
Return with valve closed
U S NAVY
ORANGE BACKGROUND
BLACK LETTERING
CAUTION:
COMBUSTIBLE
METHYL CHLORIDE
(REFRIGERANT)
U S NAVY
RED BACKGROUND
WHITE LETTERING
CAUTION:
To be used only by authorized medical personnel
ETHYLENE
U.S NAVY
BLACK LETTERING
YELLOW BACKGROUND
BLACK LETTERING
CAUTION:
To be used only by authorized personnel
CARBOXIDE
(FUMIGANT)
U S NAVY
GRAY BACKGROUND
BLACK LETTERING
DRY,
WATER-PUMPED
NITROGEN
Return with at least 25 psi.
internal pressure
U S NAVY
YELLOW BACKGROUND
BLACK LETTERING
CAUTION:
POISONOUS WHEN BREATHED
CHLORINE
U S NAVY
RED BACKGROUND
WHITE LETTERING
DANGER!
HIGHLY FLAMMABLE
HYDROGEN
Return with at least 25 psi.
internal pressure
U.S. NAVY
BLACK LETTERING
GREEN BACKGROUND
WHITE LETTERING
KEEP AWAY FROM OIL AND GREASE
AVIATORS' BREATHING
DRY OXYGEN
Return with at least 25 psi.
internal pressure
U S NAVY
BLACK LETTERING
YELLOW BACKGROUND
BLACK LETTERING
FREON-12
DICHLORODIFLUOROMETHANE
U S NAVY
RED BACKGROUND
WHITE LETTERING
CAUTION:
To be used only by authorized personnel
METHYL BROMIDE
U S NAVY
BLACK LETTERING
GREEN BACKGROUND
WHITE LETTERING
KEEP AWAY FROM OIL AND GREASE
OXYGEN
Return with at least 25 psi
internal pressure
U.S NAVY
BLACK LETTERING
ORANGE BACKGROUND
BLACK LETTERING
OIL-FREE
HELIUM
(MEDICAL AND DIVING)
Return with at least 25 psi.
internal pressure
U.S NAVY
ORANGE BACKGROUND
BLACK LETTERING
CAUTION:
To be used only by authorized medical personnel
CYCLOPROPANE
U.S NAVY

102.25

Figure 5-51.—Standard decalcomanias for Navy gas cylinders.

or defects require the cylinder to be turned in for repair:

1. Severely dented, gouged, or corroded

2. Evidence of fire damage (carbon deposits in valves or safety plugs of cylinders containing acetylene or other flammable gases)

3. Bulges (deformation of cylinders from internal pressures)

4. Damaged, split, or leaking seams (low-pressure cylinders containing flammable gases such as acetylene)

When it is impractical to bleed the pressure off of defective cylinders, or to turn them over to a reconditioning center, they may be surveyed and jettisoned at sea. An approved survey report is to be turned in as required.

HANDLING AND STOWING CYLINDERS

It must be remembered constantly that ALL compressed gases are hazardous. Many detailed precautions could be set down with regard to the handling and stowing of these gases. The more important ones are summarized in this section.

The term *stowage* as used in the following paragraphs refers to articles under the control of the supply officer in general stores. They may be articles drawn on for the ship's own use, or cargo being transported. It does not refer to cylinders that have been removed from stores or from cargo and transferred to the shops or other locations for use.

The term *ready service* refers to cylinders or other articles which have been transferred from stores and are actually located in a shop or near a place where they are to be used. It is not necessary that the articles be in actual use, but they must be ready for use.

Handling Cylinders

Cylinders that contain flammable and/or explosive gases must be handled with extreme care. Every effort should be made to avoid dropping them or allowing them to strike too hard against each other or any other object. Take every precaution to prevent bumping or striking the discharge valves.

When cylinders are being handled, the cylinder valve outlet cap and the cylinder valve protecting cap must be in place. Unless ready-service cylinders are secured in special portable racks, regulators must be removed and caps replaced before the cylinders are moved to a new location. Even then, it is best to remove the regulators and replace the caps for safety.

Be very careful when loading or transferring cylinders, especially when using a crane or derrick. The cylinders must be secured in a cradle, suitable platform, rack, or special container such as a sandbag. Electromagnets must never be used. A cylinder moved by hand should be tilted slightly and rolled on its bottom edge, without dragging or sliding. Hooks or lines through the valve protection cap must not be used for hoisting cylinders. Cylinders frozen to the deck, or otherwise fixed, must not be pried loose with crowbars or similar tools.

When gas cylinders are transported on a hand truck, they must be held securely in position. The truck should be fastened to a bulkhead or stanchion as soon as the destination is reached. The truck should be constructed as follows:

1. Frame sufficiently rigid to permit handling with tackle.

2. Grips or handles ending in a vertical line with the aft side of the wheels. (This facilitates fastening to a bulkhead.)

3. Platform fitted with sides to prevent the cylinders from sliding off.

4. Metal strap clamps provided for retaining the tops of the cylinders in place. Chains are not to be used as retainers since they normally are a little slack; the cylinders can shift and cause an accident.

Stowage of Compressed Gases

In general, weather-deck stowage will be provided for flammable and explosive gases. However, in specific cases, below-deck stowage is approved; depending on the particular type, mission, and arrangement of the ship. In such cases, these approved locations are shown on the ship's plans.

Compressed gases aboard all ships, except cargo ships, should be stowed only in compartments designated by NAVSEA, as shown in applicable plans for the ship. In such cases, the following precautions must be observed:

1. Necessary steps should be taken to keep the maximum temperature of the stowage compartment below 130°F.

2. When provisions are made for mechanical ventilation, this ventilation should be operated in accordance with the damage control classification assigned. The classification for closures of this system are either "Z," "W," or "W."

3. The installation of portable electric wiring and equipment is not permitted in compartments designated for the stowage of flammable or explosive gases.

4. Flammable materials, especially grease and oil, must be kept out of the stowage space.

5. Each cylinder must be securely fastened individually, in the vertical position (valve end up), and by such means as metal collars. Other arrangements are approved for cargo ships fitted especially for cylinder transport.

6. Oxygen and chlorine must be stowed in compartments separate from flammable gases. Inert or nonflammable gases may be stowed in any compartment designated for compressed-gas stowage.

7. Compartments containing compressed gases must be ventilated for 15 minutes before entry in the event that ventilation has been closed down. A suitable sign to this effect should be posted on the outside of the access door.

When compressed gas is stowed on the weather deck, the following additional precautions must be observed:

1. Oxygen and chlorine cylinders must not be close to the fuel-gas cylinders. Normal practice is to stow gas cylinders on one side of the ship and to stow oxygen and chlorine cylinders on the other side.

2. Cylinders containing compressed gases should be stowed for the greatest possible protection. During the winter, cylinder valves must be protected against the accumulation of snow and ice. Warm water (not boiling) should be used to thaw ice accumulations in cylinder valve caps and outlets. Boiling water may melt the fusible plugs. During the summer, cylinders must be screened from the direct rays of the sun.

3. Make every effort to prevent corrosion of threaded connections of cylinders that are stowed for extended periods of time. The use of grease, lubricants, or flammable corrosion inhibitors on oxygen cylinders is NOT permitted. Oil or grease in the presence of oxygen under pressure will ignite violently.

4. The stowage area should be as far away as practical from navigation stations, fire control stations, and gun mounts.

Ready-Service Storage Rules

1. Cylinders in actual use, and those attached to welding, fire-fighting, medical, refrigeration, or similar apparatus, ready for use, are permitted below decks outside of the stowage compartment.

2. The following special precautions must be taken with oxygen and fuel-gas cylinders for welding:

a. The number of cylinders of gas needed to equip each authorized gas cutting and welding position may be installed in shops. The number of authorized positions will be determined from either a NAVSEA-approved plan or the machinery specifications for the shop concerned.

b. Cylinders must be securely fastened in a rack. The rack must be securely fastened to the bulkhead at the designated location.

c. Cylinders attached to NAVSEA-approved damage control equipment may be stowed below decks in repair lockers. Spare cylinders used for this purpose may be stowed in the same locations.

d. Welding units may be removed from the designated stowage location in order to perform work at some remote location in the ship. These units must be returned to the designated stowage location immediately after you complete your work. The equipment must be attended at all times while it is away from its regular stowage location.

e. A card showing the following must be posted at the designated stowage location of each unit:

WARNING

> THIS UNIT IS NOT SECURE WHILE PRESSURE SHOWS ON GAGES, OR WHEN CYLINDERS ARE NOT FIRMLY FASTENED TO RACK OR TO BULKHEAD, OR WHEN RACK IS NOT FIRMLY FASTENED TO BULKHEAD. IF REMOVED FROM THIS LOCATION, THIS UNIT IS TO BE CONSTANTLY ATTENDED UNTIL RETURNED AND SECURED.

f. A card showing the following must be attached to each unit:

> RETURN TO (DESIGNATED LOCATION) IMMEDIATELY ON COMPLETION OF WORK.
>
> UNIT SHALL NOT BE LEFT UNATTENDED WHILE AWAY FROM ABOVE LOCATION.
>
> UNIT IS NOT SECURE WHILE PRESSURE SHOWS ON GAGES, OR WHEN CYLINDERS ARE NOT FIRMLY FASTENED TO RACK OR BULKHEAD, OR WHEN RACK IS NOT FIRMLY FASTENED TO BULKHEAD OR STANCHION.

See *Naval Ships' Technical Manual*, chapters 550 and 074, volume 3, for detailed precautions.

3. Fire extinguishers that use gases, fire-extinguishing cylinders permanently connected to fixed fire-extinguishing systems, and chemical canisters for oxygen-breathing apparatus may be stowed in the vicinity in which they would be used.

Disposition of Empty Cylinders

Empty cylinders should be delivered to the nearest naval supply depot. Valves should be closed and under some positive pressure, except where the design of the valve does not permit closing, as is the case with fire extinguishers. The pressure is necessary to prevent condensation of atmospheric moisture on the internal walls. In the case of acetylene cylinders, the pressure prevents loss of the solvent (acetone) and/or entry of air, if the cylinders cool considerably below the temperature at which they were discharged.

Sometimes, cylinders used for aviator's breathing oxygen, dry nitrogen, argon, or dry air are found to have open valves and/or a positive internal pressure of less than 25 psi. These cylinders should be tagged with the explanation that they must be dried before they are refilled.

GAS CYLINDER VALVES

Navy standard gas cylinder valves are of two basic designs: packed valves and diaphragm-type packless valves.

Packed valves require a packing material around the valve stem to prevent leakage. The valve stem is packed to prevent gas from leaking out around the stem when the valve is open. MIL-V-2 covers the authorized packing material for gas cylinder valves.

Packless valves are sealed against leakage around the valve stem by flexible metallic diaphragms securely clamped to the valve bonnets. The basic packless design may be classified into two types: nonbackseating and backseating. The nonbackseating type is designed so that the metallic sealing diaphragms may not be replaced under pressure. In the backseating type the metallic diaphragms may be replaced without undue hazard or loss of contained gases if the outlet cap is in place and secure. Diaphragms in packless valves should be replaced only by activities carrying spare diaphragms specifically designed for the valves in need of reconditioning. These diaphragms are made from materials selected for service at varying high pressures. In addition, they are often designed only for use with valves built by a given manufacturer and for a specific gas.

The Navy gas valve program (and concerned civilian agencies) provides noninterchangeable valve outlets and connections for different gases to prevent use of the wrong gas at any time.

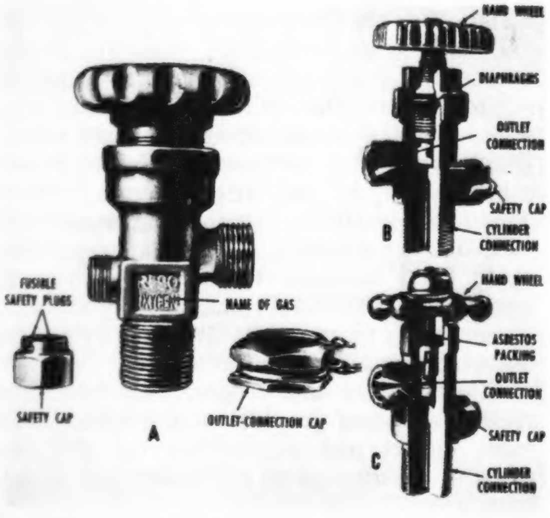
Construction and Identification of Valves

Valves designed to control the flow of compressed gases are forged of brass, bronze, or steel, and are made in various shapes and sizes.

Figures 5-52 and 5-53 show typical gas cylinder valves. The valves are opened and closed with either hand-operated or wrench-operated spindles. When the valves are open, gas flows through a threaded male cylinder connection into the valve body and past the valve outlet connection into the pressure regulator. (Pressure regulators reduce the pressure of compressed gases from the cylinder pressure to the desired working pressure. All regulators are marked with the name of the gas for which they are intended.)

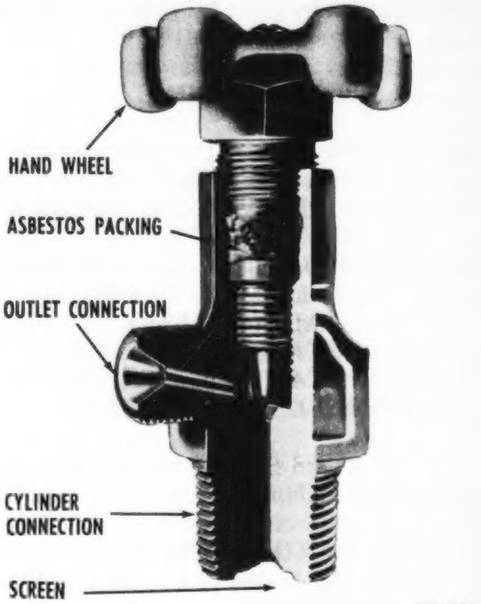
To prevent leakage of gas above the valve stem when the valve is opened, each valve is equipped with asbestos, leather, or rubber packing or metal diaphragms. Most valves have safety devices. (The safety devices for acetylene and ammonia are in the cylinders rather than in the valves.) These safety devices consist of fusible metal plugs, rupture disks, or both. Spring-loaded safety devices are used for some gases. If heat causes too much pressure, the fuse plugs melt and the disks burst, releasing the contents of the cylinder. Acetylene valves have screens in the cylinder connections; other valves do not.

Valves manufactured according to the latest military specifications have the name of the gas, or service for which they are designed, indented on at least one of the flats on the sides of the valves. Valves must be used only for the gases or fluids indicated. Otherwise, personnel may be injured or the equipment may be damaged.


HAND WHEEL
DIAPHRAGMS
OUTLET CONNECTION
SAFETY CAP
B
CYLINDER CONNECTION
FUSIBLE SAFETY PLUGS
OXYGEN
NAME OF GAS
SAFETY CAP
A
OUTLET-CONNECTION CAP
HAND WHEEL
ASBESTOS PACKING
OUTLET CONNECTION
SAFETY CAP
C
CYLINDER CONNECTION

103.110

Figure 5-52.—Oxygen cylinder gas valves: (A) external view of one type of valve, with related safety and outlet-connection caps; (B) cutaway view of same valve, showing diaphragms to prevent gas leakage when valve is opened; (C) cutaway view of another type of valve, with asbestos packing to prevent gas leakage when valve is opened.


HAND WHEEL
ASBESTOS PACKING
OUTLET CONNECTION
CYLINDER CONNECTION
SCREEN

103.111

Figure 5-53.—Cutaway view of an acetylene-cylinder valve, showing asbestos packing.

Safety Devices for Valves

Military specifications and ICC regulations require that valves designed for certain services be fitted with safety devices. These devices guard against a buildup of hazardous pressures caused by heat. This can easily happen with CO_2 cylinders used for fire fighting in firerooms and enginerooms. Pressure can also build up from overcharging or similar causes. These safety devices may be divided into four general categories based on functional design as follows:

1. FUSIBLE PLUGS. A fusible plug may be described as a threaded hex-head plug with a center filled with fusible metal. When the cylinder is overheated, the fusible metal melts and permits the gas to escape. This type of device is used on chlorine, freon, acetylene, and such gases.

2. SPRING-LOADED SAFETY DEVICE. These devices usually function as "pop" valves that open to release excess pressure when pressure in the cylinder overcomes spring tension. Devices of this sort are used on liquefied petroleum gas valves. They operate generally at about 150 percent of the cylinder's ICC-approved pressure.

3. UNBACKED SAFETY CAP WITH RUPTURE DISK. This safety device is essentially a safety cap that covers a safety port in the valve. The cap retains a breakable disk firmly over the safety port. Pressures ranging from 2,600 to 3,000 psi will rupture the safety disk and allow the gas in the cylinder to vent to the atmosphere. This type of safety device is used in carbon dioxide service.

4. BACKED SAFETY CAP WITH RUPTURE DISK. Backed safety caps with rupture disks are essentially the same as those described in paragraph 3 above. However, the breakable disk is supported by fusible metal contained in the safety cap thus blocking off escape ports. This cap works when the cylinder, valve, and therefore the fusible metal, are heated above the melting temperature. When the pressure within the cylinder reaches 2,600 to 3,000 psi, the breakable disk ruptures and reduces the pressure. This type of device is used commonly on air, argon, helium, hydrogen, nitrogen, and oxygen valves.

Leaking Valves

Cylinders with leaking or defective valves should be tagged as such and turned in to the nearest naval supply depot for overhaul.

Pressure Control

The pressures of the various cylinder gases must be reduced to a suitable working pressure before they can be safely used. Pressure is reduced by a regulator or reducing valve which controls the flow of gas from the cylinder. Regulators are the single-stage type, which reduces gas pressure in one step, or the double-stage type, which reduces pressure in two steps or stages.

Safety Precautions

Cylinders, regulators, hoses, and torches are important parts of the shop equipment for heating, welding, and cutting. Learn and follow these safety rules for this type of equipment.

1. Never fill a cylinder with a gas other than the gas for which it is specifically designated. Never remove or change the decals.
2. Never return an empty cylinder without making sure that valves are closed and that protective caps are in place.
3. Never drop the cylinders or let them strike against each other.
4. Never use cylinders as rollers or supports.
5. Never hammer or strike the valve wheel to open or close the valve. Use only the wrenches or tools approved for that purpose.
6. If valve outlets are iced, use only warm water to free them. Never use hot or boiling water.
7. Never use a cylinder that is improperly marked; that is, where the paint color doesn't agree with the information on the decal.
8. Never use a lifting magnet or a sling to raise or handle a cylinder.
9. Be careful not to mix full and empty cylinders in a stowage rack.
10. Never tamper with safety devices on the valves or cylinders.
11. Never store oxygen and acetylene cylinders in the same immediate area.
12. Be especially careful that you never strike an arc on gas cylinders or sealed metal cylinders of any kind.
13. Acetylene and low-pressure fuel-gas cylinders, which have been stowed in a horizontal position, must be placed in a vertical position for at least 2 hours before you use them. This will allow the porous filler material inside the cylinder to settle.

MAINTENANCE AND REPAIR OF VALVES

Periodic maintenance is the best way to extend the service life of valves and fittings. As soon as you see a leak, check to see what is causing it; then apply the proper remedy. This remedy may be as simple as tightening a packing gland nut. A leaking flange joint may need only to have the bolts tightened or to have a new gasket inserted. Dirt and scale, if allowed to collect, can cause leakage. Loose hangers permit sections of a line to sag. The weight of the pipe and the fluid in these sagging sections may strain joints to the point of leakage.

Whenever you are going to install a valve, make sure that you know its function. In other words, is it supposed to prevent backflow, start flow, stop flow, regulate flow, or regulate pressure? Look for the information that is stamped on the valve body by the manufacturer: type of system (oil, water, gas); operating pressure; direction of flow; and other information.

You should also know the operating characteristics of the valve, the type of metal it is made of, and the type of end connection it has. Operating characteristics and material affect the length and kind of service that a valve will give. End connections indicate whether or not a particular valve is suited for installation in the system.

Valves should be installed in accessible places, and with enough headroom to allow for full operation. Install valves with stems pointing upward, if possible. A stem position between straight up and horizontal is acceptable, but avoid the inverted position (stem pointing downward). When the valve is installed in the latter position, sediment will collect in the bonnet and score the stem. When a line is subject to freezing temperatures, liquid trapped in the valve bonnet may freeze and rupture it.

Globe valves may be installed with pressure either above or below the disk. It will depend upon which method will be best for the operation, protection, maintenance, and repair of the machinery. You should ask what would happen if the disk became detached from the stem? It is a major consideration in determining whether pressure should be above the disk or below it. Check the blueprints for the system to see which way the valve must be installed. Pressure on the wrong side of the disk can cause very serious damage.

Valves which have been in constant service over a long period of time will eventually require gland tightening, replacing, or a complete overhaul of all parts. If a valve is not doing the job, it should be dismantled and all parts inspected. All defective parts must be repaired or replaced.

GLOBE VALVES

The repair of glove valves (other than routine renewal of packing) is generally limited to refinishing the seat and disk surfaces. You should take the precautions described below when you do this work.

When refinishing the valve seat, remove no more material than is necessary. Valves that do not have replaceable valve seats can be refinished only a limited number of times.

Before you begin any repair work on the seat and disk, check the disk to make certain it is secured rigidly to, and is square on, the valve stem. Also, check to be sure the stem is straight. If the stem is not straight, the disk cannot seat properly. Inspect the seat and disk carefully for evidence of wear, for cuts on the seating area, and for improper fit of the disk to the seat. If the disk and the seat appear to be all right, they should be spotted-in to find out whether they actually are in good condition.

Spotting-in Valves

Spotting-in is the method used to determine visually whether or not the seat and the disk make good contact with each other. To spot-in a valve seat, first apply a thin coating of prussian blue evenly over the entire machined face surface of the disk. Then insert the disk into the valve and rotate it a quarter turn, using a light downward pressure. The prussian blue will adhere to the valve seat at those points where the disk makes contact. Figure 5-54 shows what correct and imperfect seals look like when they are spotted-in.

After you have examined the seat surface, wipe all the prussian blue off the disk face surface. Apply a thin, even coat of blue to the contact face of the seat. Again, place the disk on the seat and rotate the disk a quarter of a

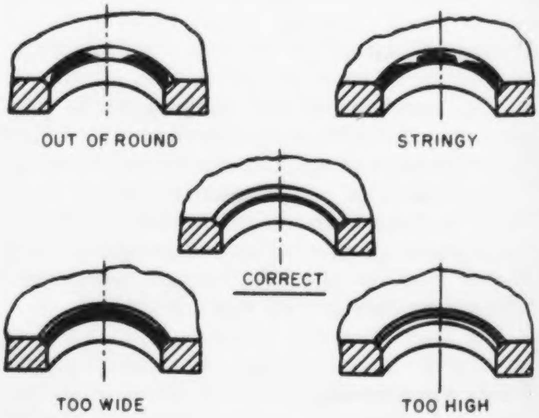


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Figure 5-54.—Examples of spotted-in valve seats.

turn. Examine the blue ring that appears on the disk. It should be unbroken and of uniform width. If the blue ring is broken in any way, the disk is not making a proper fit.

Grinding-in Valves

Grinding-in is the manual process used to remove small irregularities by grinding together the contact surfaces of the seat and disk. Grinding-in should not be confused with refacing processes in which lathes, valve reseating machines, or power grinders are used to recondition the seating surfaces.

To grind-in a valve, first apply a small amount of grinding compound to the face of the disk. Then insert the disk into the valve and rotate the disk back and forth about a quarter of a a turn. Shift the disk-seat relation from time to time so that the disk will be moved gradually, in increments, through several rotations. During the grinding-in process, the grinding compound will gradually be displaced from between the seat and disk surfaces. Therefore, it is necessary to stop every minute or so to replenish the compound. When you do this, wipe both the seat and the disk clean before applying the new compound to the disk face.

When it appears that the irregularities have been removed, check your work by spotting-in the disk to the seat in the manner previously described.

Grinding-in is also used to follow up all machining work on valve seats or disks. When the seat and disk are first spotted-in after they have been machined, the seat contact will be very narrow and will be located close to the bore. The grinding-in, using finer and finer compounds as the work progresses, causes the seat contact to become broader. The contact area should be a perfect ring covering approximately one-third of the seating surface.

Be careful that you do not overgrind a seat or disk. Overgrinding tends to produce a groove in the seating surface of the disk. It may also round off the straight, angular surface of the disk. Overgrinding must be corrected by machining.

Lapping Valves

When a valve seat contains irregularities that are too large to be removed by grinding-in, you can remove them by lapping. A cast-iron tool (LAP) of exactly the same size and shape as the disk is used to true the seat surface. Two lapping tools are shown in figure 5-55.

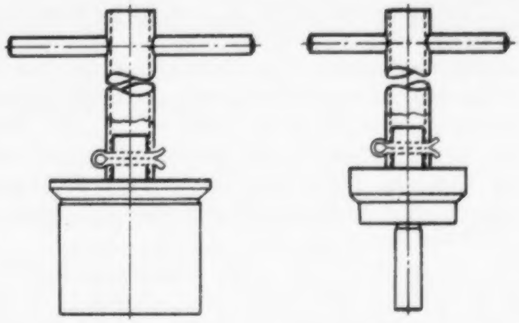
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Figure 5-55.—Lapping tools.

Here are the most important points to remember whle using the lapping tool.

1. Do not bear heavily on the handle of the lap.
2. Do not bear sideways on the handle of the lap.
3. Change the relationship between the lap and the seat so that the lap will gradually and slowly rotate around the entire seat circle.
4. Keep a check on the working surface of the lap. If a groove develops, have the lap refaced.
5. Always use a clean compound for lapping.
6. Replace the compound often.
7. Spread the compound evenly and lightly.
8. Do not lap more than is necessary to produce a smooth, even seat.
9. Always use a fine grinding compound to finish the lapping job.
10. When you complete the lapping job, spot-in and grind-in the disk to the seat.

Use only approved abrasive compounds to recondition seats and disks. Compounds for lapping and grinding disks and seats are supplied in various grades. Use a coarse grade compound when extensive corrosion or deep cuts and scratches are found on the disks and seats. Use a compound of medium grade to follow up the coarse grade. It may also be used to start the reconditioning process on valves that are not too severely damaged. Use a fine grade compound when the reconditioning process nears completion. Use a microscopic-fine grade for finish lapping and for all grinding-in.

Refacing Valves

Badly scored valve seats must be refaced in a lathe, with a power grinder, or with a valve reseating machine. Use the lathe, rather than the reseating machine to reface all disks and all hard surfaced seats. Work that must be done on a lathe or with a power grinder should be turned over to machine shop personnel. This discussion applies only to refacing seats with the reseating machine.

To reface a seat with a reseating machine (fig. 5-56), attach the correct 45-degree facing cutter to the reseating machine. With a fine file, remove all high spots on the surface of the flange upon which the chuck jaws must fit. Note that a valve reseating machine can be used ONLY with a valve in which the inside of the bonnet flange is bored true with the valve seat. If this condition does not exist, the valve must be reseated in a lathe, and the inside flange bored true.

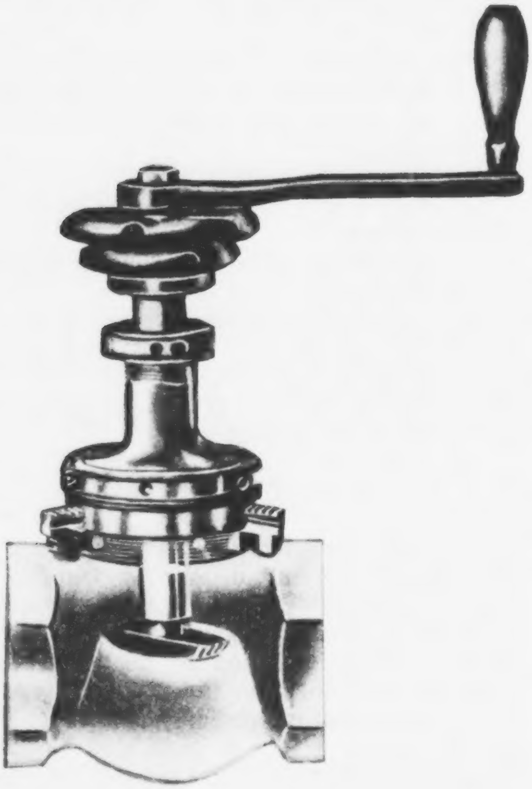

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Figure 5-56.—Valve reseating machine.

Before placing the chuck in the valve opening, open the jaws of the chuck wide enough to rest on the flange of the opening. Tighten the jaws lightly so that the chuck securely grips the sides of the valve opening. Tap the chuck down with a wooden mallet until the jaws rest firmly and squarely on the flange. Then tighten the jaws further.

Adjust and lock the machine spindle in the cutting position and start the cutting by turning slowly on the crank. Feed the cutter slowly so that very light shavings are taken. After some experience, you will be able to know by the feel whether or not the tool is cutting evenly all around. Remove the chuck to see if enough metal has been removed.

Be sure the seat is perfect. Then remove the 45-degree cutter and face off the top part of the seat with a flat cutter. Dress the seat down to the proper dimensions, as follows:

Width of Seat	Size of Valve
1/16 inch	1/4 to 1 inch
3/32 inch	1 1/4 to 2 inches
1/8 inch	2 1/2 to 4 inches
3/16 inch	4 1/2 to 6 inches

After the refacing, grind-in the seat and disk. Spot-in as necessary to check the work. A rough method of spotting-in is to place pencil marks at intervals of about one-half inch on the bearing surface of the seat or disk. Then place the disk on the seat and rotate the disk about a quarter of a turn. If the pencil marks in the seating area rub off, the seating is considered satisfactory.

Repacking Valve Stuffing Boxes

If the stem of a globe valve is in good condition, stuffing box leaks can usually be stopped by setting up on the gland. If this does not stop the leakage, repack the stuffing box. The gland must not be set up or packed so tightly that the stem binds. If the leak persists, a bent or scored valve stem may be the cause of the trouble.

Coils (string) and rings are the common forms of packing used in valves. The form to be used in a particular valve will be determined, in part, by the size of the packing required. In general, rings are used in valves that require packing larger than one-fourth inch. When a smaller size is required, string packing is generally used.

When you repack a valve stuffing box, place successive turns of the packing material around the valve stem. When strong packing is used, coil it around the valve stem. Bevel off the ends to make a smooth seating for the bottom of the gland. Then put on the gland and set it up by tightening the bonnet nut or the gland bolts and nuts. To prevent the strong packing from folding back when the gland is tightened, wind the packing in the direction in which the gland nut is to be turned. Usually, where successive rings are used, the gaps in the different rings should be staggered.

Gate, globe, angle, and stop check valves are made to back seat the stem against the valve bonnet when the valve is fully opened. Back seating of these valves is a safety feature to eliminate the possibility of the stem being forced out under pressure while the valve is fully opened. Back seating makes possible the repacking of the stem stuffing box under pressure. However, you should attempt this only in emergencies and with extreme caution.

GATE VALVES

The manner in which a gate valve is used has a great deal to do with its service life. Gate valves should always be used either wide open or fully closed; never in a partially opened position. When a gate valve is partly open, the gate is not held securely, but swings back and forth with the pulsation of the flow. As the gate swings, it strikes the valve body and the finished surfaces, nicking and scoring them. When these surfaces are imperfect, the valve gate cannot set accurately and seal off the flow. A gate valve should never be installed in any position where a throttling or flow-regulating valve is required. A globe valve should be used in those situations.

Lapping is the best way to correct gate valve defects such as light pitting or scoring and imperfect seat contact. The lapping process is basically the same for gate valves as it is for globe valves. The exception is that the lap is turned by a handle which extends through the end of the valve body. Remove the valve from the system. Insert the lapping tool, without its handle, into the valve so that it covers one of the seat rings. Then attach the handle to the lap and begin the lapping. The wedge gate can be lapped to a true surface, using the same lap that is used on the seat rings. (CAUTION: DO NOT use the gate as a lap.)

Do not remove any more material than is necessary. You can resurface a gate valve only a limited number of times. By removing too much material you will reduce the number of times the surface can be refinished, and the life of the valve.

Leakage around the stem of a gate valve is caused by troubles similar to those in leaking globe valves. The same procedure is used to stop these leaks in both valves.

CHECK VALVES

Leaks are the principal trouble found in check valves. Leakage is caused by a pitted disk or valve seat. Pitting is usually caused by abrasives caught between the disk and the seat.

When a check valve requires maintenance because of pitting, the work will depend upon the type of disk in the valve. With a ball-type disk, you will have to replace the ball and grind the seat. A flat or conical disk, can be repaired by grinding-in the disk to its seat with a fine grinding compound.

Remember that fluid will flow through them in only one direction. Be sure that they are installed correctly.

HYDRAULIC CONTROL VALVES

The weapons department personnel test and care for the hydraulic control valves in magazine sprinkling systems. However, DCs will handle leaks and other failures in these valves.

Most leaks in these valves are caused by a failure of the leather disk insert. The flow of water tends to force these inserts to curl up over the valve seat. When that happens, the valve is not completely tight when it closes. These leather inserts should be replaced with a rubber disk as soon as possible.

Other troubles with these valves include leakage of hydraulic oil past the piston of the main control valve, a broken closing spring, leakage of hydraulic oil through the upper packing gland, or leakage of water through the lower packing gland.

You may see a loss of hydraulic power after the valve opens or if the valve will not stay open. When that happens, the hydraulic oil is probably leaking past the piston or through the packing gland.

If the valve will not close when hydraulic pressure is released, check for a broken spring or binding of the stem. The stem may bind because the packing is too tight.

Before you repair or replace parts in a magazine sprinkling system control valve, close the firemain cutout valve in the supply line to the control valve, then drain the supply piping.

DUAL SOLENOID CONTROL VALVES

The dual solenoid control magazine sprinkling valve is an electric-hydraulic-operated valve. When you work on this valve, always have an electrician working with you. There are two good reasons for this: (1) a beginner could accidentally flood a compartment; and (2) unless you have a good knowledge of electricity or have an electrician, you are taking a risk.

Table 5-3.—Troubleshooting Chart for Main Valve of the Dual Solenoid Control Valve

Trouble	Probable Cause	Remedy
Main valve fails to to open when operated electrically	Lack of electrical power	With operating switch closed, have EM check to see if there is proper voltage to No. 1 solenoid.
	Failure of solenoid to position pilot valve properly	Check linkage for binding.
	Burned out solenoid coil	Check for visible evidence. Have EM check the coil for direct shorts or for breaks. If necessary, replace the coil.
	Stuck pilot valve	Try to turn the pilot valve manually. If it is hard to turn, remove it for repair. (To leave it in when it is stuck so that solenoid cannot turn it will cause the solenoid to overheat and perhaps burn out.)
	Plugged drain line	If main valve fails to open when pilot valve is properly positioned, inspect the drain line to see if it is plugged; remember that fluid should discharge from the drain line each time the main valve opens.
	Main valve stuck closed	Position the control to open the valve and remove the tubing from the control to the main valve cover; if the main valve still fails to open, it must be disassembled and freed.
	Ruptured diaphragm	This condition will be apparent when the valve is disassembled.
Main valve opens slowly	Pilot valve is stuck part way open	Check linkage for binding; try to turn the pilot valve manually (if it turns hard, it must be removed for repair).
	Drain line partially plugged	Inspect the drain line and remove obstruction.
Main valve fails to close electrically	Lack of electrical power	Have Electrician's Mate make sure that proper voltage is being supplied to the No. 2 solenoid.

11.395.1

Table 5-3.—Troubleshooting Chart for Main Valve of the Dual Solenoid Control Valve—Continued

Trouble	Probable Cause	Remedy
	Failure of the solenoid to position the pilot valve properly	Check the linkage for binding.
	Burned out solenoid coil	Check for visible evidence; have Electrician's Mate check the coil for direct shorts or for breaks; if necessary, he should replace the coil.
	Stuck pilot valve	Turn the pilot valve manually, and if it proves hard to turn, remove it for repair (remember that a stuck pilot valve may cause the solenoid to burn out).
	Plugged supply line	Loosen the pipe plug in the top of the main valve indicator, and with the pilot positioned to close the main valve, watch for a steady flow; if the flow stops, it means that the main valve inlet to the pilot valve, or the tubing from the pilot valve cover, or the pilot valve itself is plugged, and you will have to work back from the main valve cover to locate the point of stoppage.
Main valve fails when operated manually	Any cause listed above, except where electrical power is required	Any remedy listed above, except where electrical power is required.

11.395.2

The dual solenoid control contains two 440-volt solenoids and one microswitch with an actuator operated by mechanical linkage. Even after the mechanism has been de-energized, there is some danger of electric shock. Do not work on this valve until an Electrician's Mate has disconnected, removed, and insulated (taped) the electrical leads from the valve. You should avoid contact with the insulated leads even though you are certain they are de-energized and properly insulated.

The operating principle of the dual solenoid control valve goes back to the pressure spring and diaphragm theory. However, the actuating device is different. It is an electric switch that controls a plate-type valve. When the switch is closed, firemain pressure is constantly on top of the diaphragm. The firemain pressure, plus the spring pressure, keeps the valve closed. When the switch is opened, the plate valve rotates, closing off firemain pressure to the top of the diaphragm, and allowing what pressure is there to drain off. Now the firemain pressure beneath the diaphragm is greater than the spring pressure above, and pushes the diaphragm up to open the valve.

As long as the solenoid control valve does not leak and turns freely when manually operated, no preventive maintenance is required. Normal operation, followed by thorough flushing, should be enough to keep the valve in good working condition. If fog-foam solutions are used, you should flush and operate the valve several times to remove foam from the solenoid pilot valve system. This valve has few operational difficulties. The troubleshooting suggestions in table 5-3 should cover all corrective maintenance that may be necessary.

In addition to the troubles described in table 5-3, you may at times have trouble with leakage from the solenoid pilot valve connection. If this leakage is confined to a slow drip, the valve operation will probably be normal and it will be possible to dispose of the drain water easily. No corrective action is required in such a case, but you should look at the valve periodically to see if the leakage is increasing.

If there is too much leakage, it will be necessary to repair or replace the pilot valve.

Remove the tubing from the drain connection and put the leaking pilot valve in the closed position. You will see that the leakage comes across the lapped surfaces of the disk and distributor. These are the parts upon which you will have to make the repairs.

As you disassemble the valve, carefully note the position of both the disk and the distributor in relation to the mounting holes. Lap the disk and the distributor to a mirror finish, and as flat as possible. Use a figure-eight motion on a fine, flat carborundum stone, and avoid crowning the disk while lapping. You can use a lapping block with a medium grit compound. But you must wash the parts in a clean solvent to remove every trace of abrasive, and then bring the surfaces to a high polish.

Coat the lapped surfaces with a thin coating of any high-grade waterproof grease, and then squeeze the surfaces together. Replace the parts exactly as they were before disassembly.

To test the pilot valve, apply pressure at the supply point and rotate the stem several times. There should be no leakage when the valve is in the OFF position.

SUMMARY

This chapter covered various kinds of fire-fighting equipment and systems. All systems are not alike from one ship to the next. You will need to trace out the systems on your ship. Use the manufacturer's technical manuals to help you study your systems. To be efficient in fire fighting, you should know how to operate all of the fire-extinguishing systems and which areas of the ship these systems protect.

This chapter also covered compressed-gas cylinders and the safety precautions involved in working with them and the maintenance and repair of valves used in fire-fighting equipment and systems.

CHAPTER 6

FIGHTING THE FIRE

Various tools and equipment are used in the event of a fire. You will become more familiar with these items as you participate in the emergency drills on board your ship. In this chapter, you will be introduced to various equipment used to combat a fire and to dispose of the fire-fighting water. The basic procedures used to combat the fire and dispose of the fire-fighting water, and methods used to prevent fires, are also discussed.

FIRE PREVENTION

A fire aboard ship may start from an enemy hit, from a cigarette or match carelessly thrown away, from the spontaneous ignition of various combustible substances, from the use of spark- or flame-producing tools and equipment in an atmosphere containing explosive vapors, from the improper stowage of flammable materials, from static electricity, and from many other causes. As a Damage Controlman (DC), you have a particular responsibility to prevent fires as well as to fight them.

Damage control patrol watches and division damage control petty officers are required to make regular and frequent inspections as a part of an overall ship's fire prevention program. Such inspections should include the following:

- Check to ensure that all installed and portable fire-fighting equipment is in good working order and ready to use if the need arises. Check to ensure that the ship's firemain pressure is adequate at all times.

- Check to ensure that safe operating procedures are being followed and that personnel are taking all appropriate precautions to prevent fires.

- Check to ensure that fire hazards are not allowed to exist. There are so many different kinds of fire hazards that it is almost impossible to list them all. Among other things, keep your eyes open for spilled oil, spilled paint, greasy rags not properly stowed, improper stowage of dangerous materials, and any violation of good housekeeping procedures.

- Check to ensure that the ship's fan rooms and ventilation trunks are kept free of cleaning gear, deck gear, and miscellaneous stowage that might restrict airflow and constitute a fire hazard. Be sure to check ventilation ducts, filters, and heaters at the required intervals. These items continuously collect flammable lint and dirt that could cause a fire to spread rapidly from one compartment to another.

- Check continuously for evidence of electrical fire hazards. Report all hazards immediately to the proper authority so that qualified personnel can make repairs or take other corrective action. Some of the electrical hazards to look for are unauthorized plugs or extensions, multiple connectors, and unauthorized wiring. Anything that causes overloading of an electrical circuit is a potential fire hazard. Other fire hazards result from failure to secure electrical devices, distribution equipment, or controls in the approved manner.

- Keep a close watch on the conduct of operations that are, by their very nature, likely to present fire hazards. When necessary, see that a fire watch is posted until the conclusion of the hazardous operations. A few (by no means a complete listing) of the shipboard operations that may present special fire hazards are welding or cutting, repairing diesel engines, refueling of the ship, and loading or transferring ammunition. Whenever fuel or ammunition is being transferred, fire hoses and other fire-fighting equipment should be led out and manned to be ready for instant use. When the ship is in port for these operations, both shipboard and shore fire-fighting equipment should be placed where it will be ready for immediate use.

The list of things to be checked and inspected as a means of preventing fires could be extended almost endlessly. Instead of going on with a list, however, it may be more useful at this point to stop and formulate a few general rules for fire prevention:

RULE 1: Learn to look at everything with an eye for possible fire hazards. Develop a special kind of alertness for situations or actions that could conceivably lead to a fire.

RULE 2: Insist on proper stowage and good housekeeping procedures. Report violations to the proper authority.

RULE 3: Maintain all fire-fighting equipment in a state of maximum readiness. While this won't prevent a fire from starting, it is the best possible means of preventing the spread of fire.

RULE 4: Make sure that all fire-fighting personnel are trained to be alert to fire-fighting operations.

RULE 5: Keep up with new fire-fighting equipment and techniques. The Navy is constantly working to provide improved fire-fighting equipment and improved fire-fighting techniques. It's up to you to keep abreast of new developments in fire fighting and fire prevention.

PROTECTIVE EQUIPMENT

The Navy uses a wide variety of special fire fighter's protective equipment. It includes the oxygen breathing apparatus, protective masks, proximity suits, tending lines, and atmospheric testing equipment plus gloves, helmet, anti-flash hood and voice amplifier. You will need to know what equipment is available, how to operate it, and how to maintain it in top operating condition.

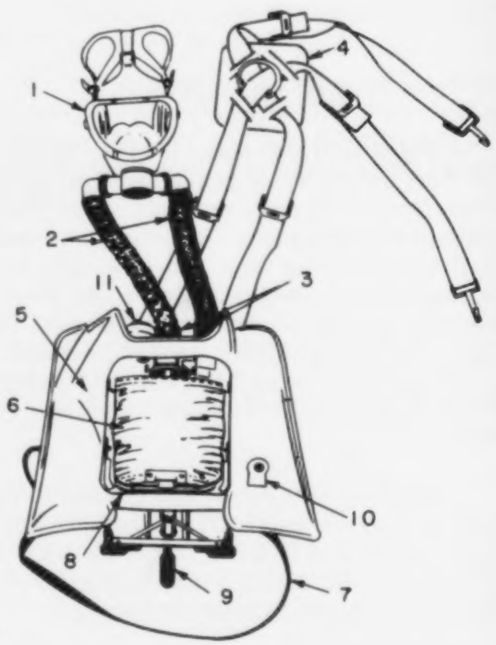
OXYGEN BREATHING APPARATUS

The type A-4 oxygen breathing apparatus (OBA) is used throughout the Navy. The OBA is an entirely self-contained breathing apparatus. It enables the wearer to breathe independently of the outside atmosphere. It produces its own oxygen and allows the wearer to enter compartments, voids or tanks that contain smoke, dust, or fire, or those that have a low oxygen content.

Major OBA Components

You will be required to wear, operate, and maintain in perfect operating condition the type A-4 OBA. To do so, you must know the various components of the OBA and their purposes. Figure 6-1 shows the components and identifies them. As you read about the various components, refer to this figure as well as to those pertaining to the individual components.

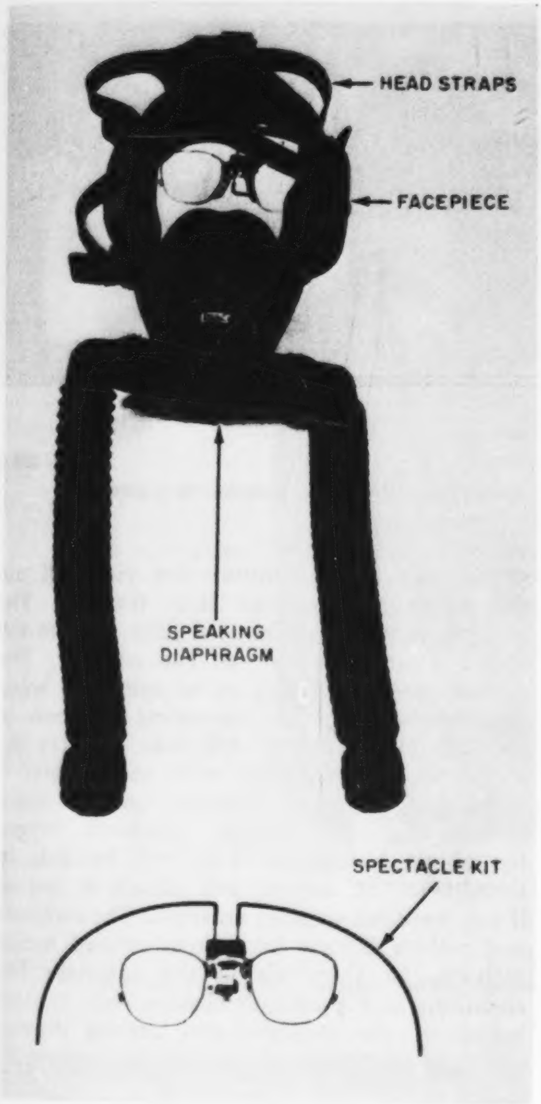
FACEPIECE.—The facepiece (fig. 6-2) contains the eyepiece, the speaking diaphragm, and the head straps. The eyepiece is a one-piece clear lens. A spectacle kit is provided that may be installed in the facepiece. Corrective lenses may be installed in the kit for individuals who require glasses. However, once the lenses are installed, only the person that the lenses are made for can



1. **Facepiece**
2. **Breathing tubes**
3. **Breathing tube couplings**
4. **Body harness and pad**
5. **Breathing bag**
6. **Breastplate**
7. **Waist strap**
8. **Bail assembly handle (standby position)**
9. **Canister release strap**
10. **Pressure relief valve and pull tab**
11. **Timer**

285.1

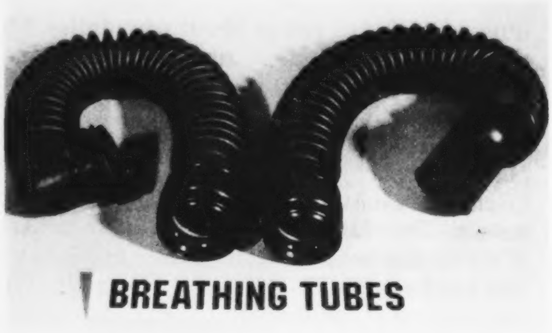
Figure 6-1.—Components of the OBA.



8.498
Figure 6-2.—Facepiece with spectacle kit installed.

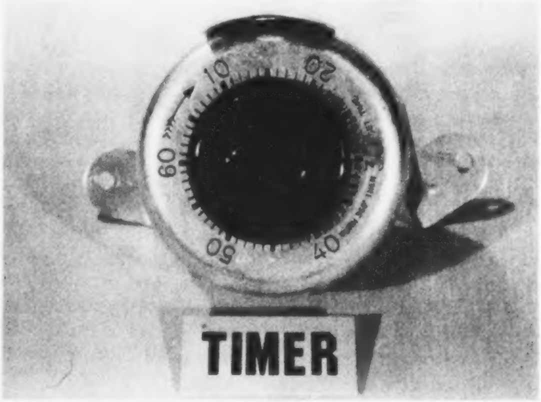
use that spectacle kit. The speaking diaphragm allows you to talk to others and to use communication devices such as sound-powered telephones. The head straps hold the facepiece snug against your face. If the straps are adjusted properly, no outside gases can get inside of the facepiece.

BREATHING BAG AND TUBES.—The OBA has a breathing bag and two breathing tubes to control the oxygen. The breathing bag contains the oxygen that is generated by the canister for you to breathe. One breathing tube transports the oxygen from the breathing bag to the facepiece (fig. 6-3); the other transports the exhaled air back to the canister. Both tubes are made of corrugated rubber. They control the flow of air and help cool the air for your comfort when you wear the OBA. The tubes are a quick-disconnect type. The tube couplings are color coded, and the supply tube is of a different size than the exhaust tube. This prevents the possibility of connecting the tubes to the wrong couplings.



285.3
Figure 6-3.—Breathing tubes.

TIMER.—The timer (figs. 6-1 and 6-4) is located so that you can check the amount of



285.4
Figure 6-4.—Timer.

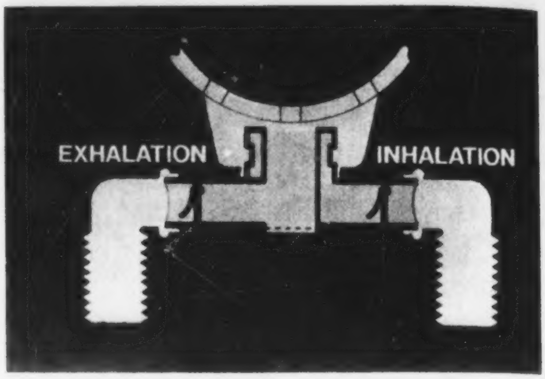
time remaining as you go about your duties. The timer's bells are made to ring for 8-10 seconds continuously.

BREASTPLATE ASSEMBLY.—The breastplate assembly (fig. 6-5) houses the plunger assembly, canister guard and holder, and the handle. The plunger pierces the copper foil seal of the canister when the canister is seated in place. The handle actuates the seating mechanism that positions the canister in its housing. When activated, the canister's chlorate candle provides you with oxygen to breathe. The canister gets very hot, but the canister guard or holder protects you from the heat produced by the canister.

COMBINATION VALVE ASSEMBLY.—The combination valve assembly is shown in figure 6-6. It directs the flow of air through the canister to the breathing bag.

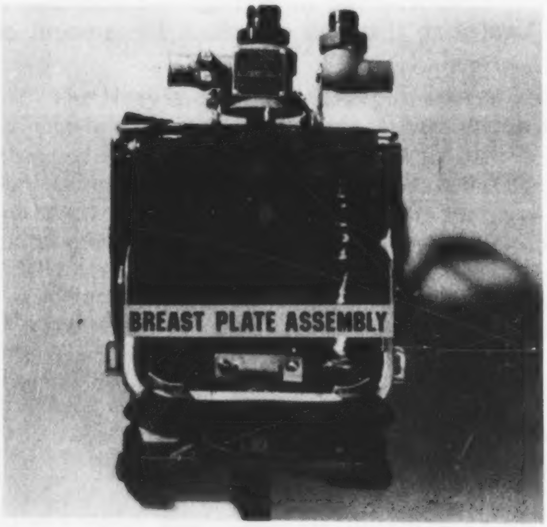
HARNESS AND WAIST STRAPS.—The OBA has two types of straps: harness and waist (fig. 6-7). The harness straps go over your shoulders and snap into D rings. They support the weight of the OBA. The waist strap goes around your body and helps keep the OBA from swinging away from you.

OBA QUICK-STARTING CANISTER.—The quick-starting canister (fig. 6-8) is painted green. This is the canister that you will use for all evolutions other than training. The training canister is discussed later. Figure 6-9 shows a cutaway view of the canister. The rubber gasket provides an airtight seal when the canister is in the operating position in the OBA. The copper foil seal protects the chemicals from moisture until the canister is ready for use. The chlorate candle, which is built into the canister, produces oxygen for about 5 minutes. You will be able to breathe in the oxygen and exhale it just as if you were not wearing an OBA. The moisture and carbon dioxide from your exhaled breath activate the chemicals in the canister. The chemicals in the canister cleanse your exhaled breath of the moisture and carbon dioxide



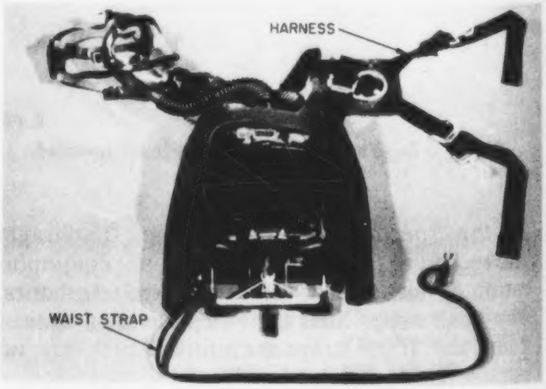
285.6

Figure 6-6.—Combination valve assembly.



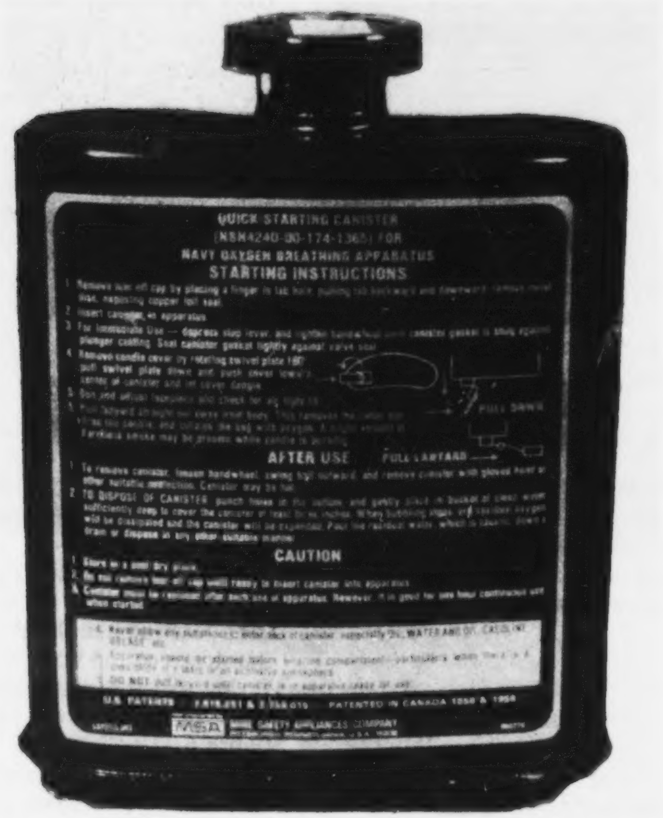
285.5

Figure 6-5.—Breastplate assembly.

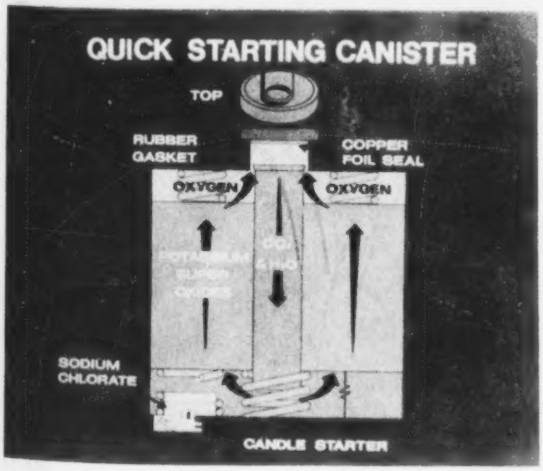


285.7

Figure 6-7.—Harness and waist strap.


QUICK STARTING CANISTER
(NSN4240-00-174-1365) FOR
NAVY OXYGEN BREATHING APPARATUS
STARTING INSTRUCTIONS
PULL DOWN
AFTER USE
PULL LANYARD
CAUTION
MSA
MINE SAFETY APPLIANCES COMPANY

5.96.2
Figure 6-8.—Front view of quick-starting canister for use with Type A-4 oxygen breathing apparatus.


QUICK STARTING CANISTER
TOP
RUBBER GASKET
COPPER FOIL SEAL
OXYGEN
OXYGEN
POTASSIUM SUPER OXIDE
CO_2 & H_2O
SODIUM CHLORATE
CANDLE STARTER

285.9
Figure 6-9.—Cross-sectional view of quick-starting canister.

and return the remainer of the air to you as you inhale.

The amount of your exertion will determine how long the canister produces oxygen. The more active you are, the faster the chemicals will be expended. The canister will last longer when you are doing mild work such as investigating shipboard damage. When you are involved in hard work, such as fighting a fire, the canister will last for about 30 minutes. Your normal breathing habits will also effect the length of time the canister will last. When you replace an expended canister with a new canister, do so only in fresh air.

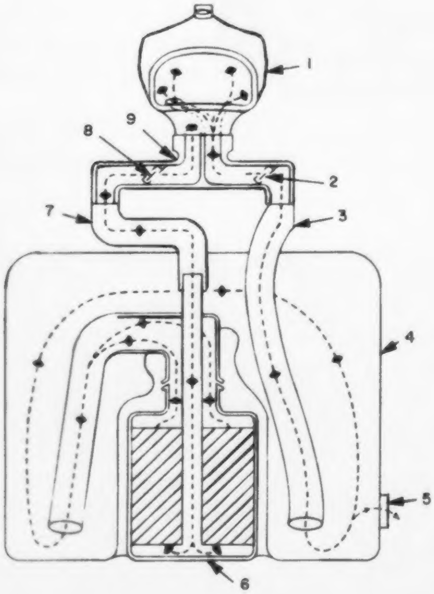
Airflow System

At this point, you should know and understand the use of each component of the

OBA. Figure 6-10 shows an OBA with a canister installed. The arrows indicate the airflow through the OBA.

As you exhale, moist breath passes through the exhalation tube (7), through the valve housing to the bottom of the canister (6), and upward through the chemical. The carbon dioxide is absorbed, and the moisture present reacts with the chemical to give off oxygen. This oxygen passes into a breathing bag (4) (part of the breastplate group) from which the inhalation tube (3) allows the breathable mixture to be drawn into the facepiece (1) by your normal intake of breath.

Check valves (2 and 8) are used in the inhalation and exhalation passages. An automatically operated pressure-relief valve (5) in the breathing bag relieves excess pressure in the breathing bag. The speaking diaphragm, as described earlier, is built into the facepiece.



1. Facepiece
2. Inhalation valve
3. Inhalation tube
4. Breathing bag
5. Pressure relief valve
6. Canister
7. Exhalation tube
8. Exhalation valve
9. Valve assembly

285.10

Figure 6-10.—Airflow system.

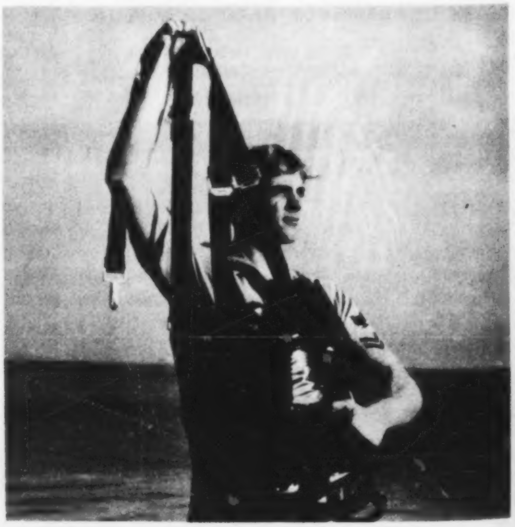
OBA Operating Procedures

Damage Controlmen use the OBA on a regular basis for fire-fighting and training purposes. It will protect you; however, improper use of the OBA could make you a personnel casualty. The following topics discuss the type A-4 OBA operating procedures. It is very important that you learn to use them properly. You should practice the operating procedures under the supervision of a leading petty officer who is qualified in the use of the OBA. Do not use the green quick-starting canister for training; check with the DCA about using a red training canister.

DONNING THE OBA.—When donning the OBA, do so in the following order:

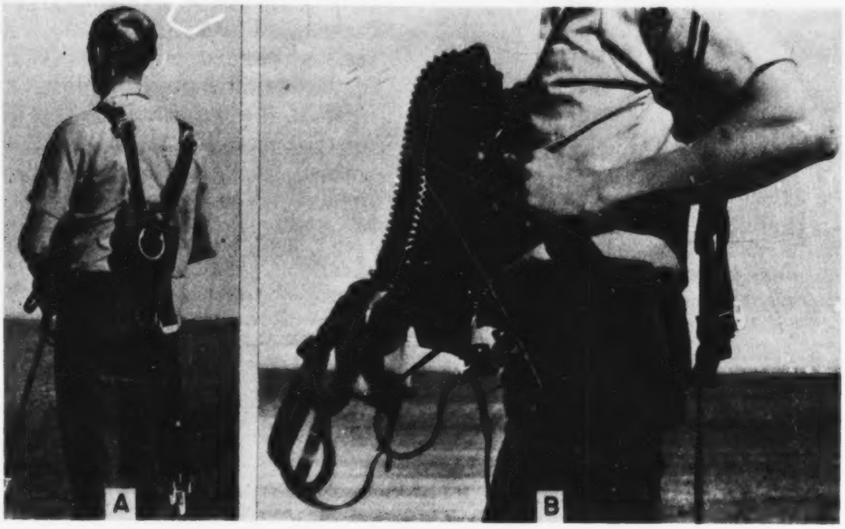
1. With one hand, grasp the facepiece at the combination valve housing and the apparatus at the operating handle. With the other hand, grasp the straps of the body harness and the body pad D ring. Bring the pad and harness over your head while positioning the OBA on your chest. See figure 6-11.

2. Find the two straps hanging free in back (view A, fig. 6-12). Attach the end of



285.11

Figure 6-11.—Step 1 of donning the OBA.



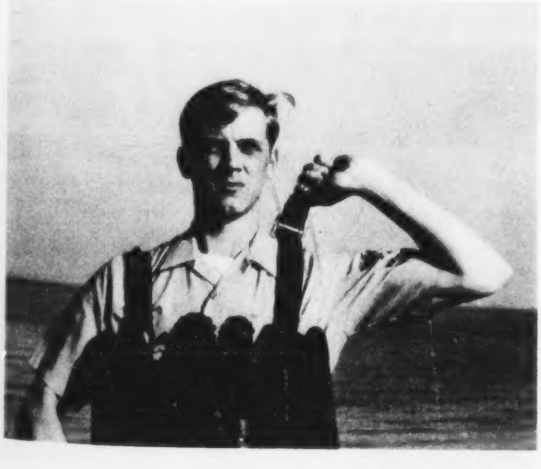
285.11.1
Figure 6-12.—Step 2 of donning the OBA.

each strap to the ring on each side of the breastplate (view B, fig. 6-12).

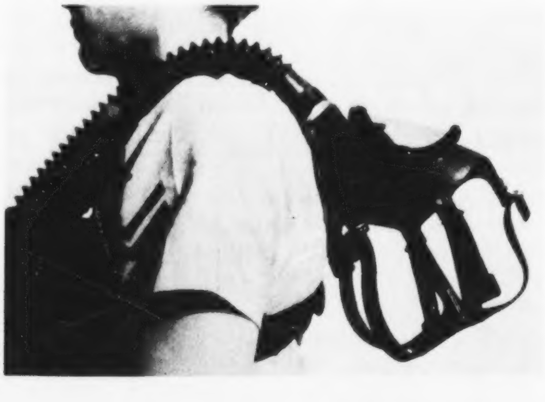
3. Position the breastplate on your chest so that the breathing tube connections are slightly below your shoulders. Your head movement should not be restricted when you don the facepiece. While holding the apparatus in this position, adjust the two underarm straps and then adjust the two shoulder straps (fig. 13) until the apparatus fits comfortably. The harness pad should be located in the center of your back down from the neck for a comfortable fit.

4. Place the facepiece over your head in the standby position (fig. 6-14) until you are ready to activate the canister.

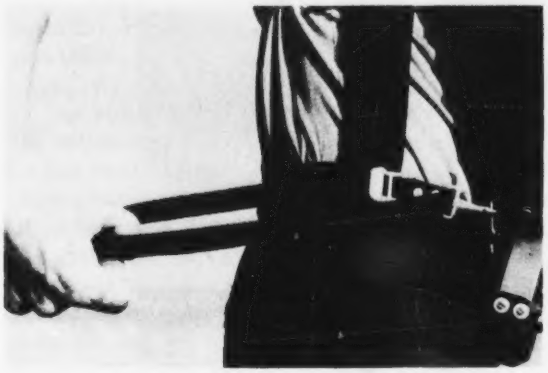
5. Snap the waist strap to the bracket on the lower side corner of the breastplate



285.11.2
Figure 6-13.—Step 3 of donning the OBA.



285.11.3
Figure 6-14.—Step 4 of donning the OBA.



285.11.4

Figure 6-15.—Step 5 of donning the OBA.

(fig. 6-15) and adjust to hold the apparatus snugly to your body. To secure the excess loop of the waist strap, wrap it under the secured part of the strap. Secure the ends of the lower body harness straps under the waist strap if they extend down to your waist after being adjusted.

6. Install the canister in the following manner:

a. Remove the tear-off cap of the canister by pulling the tab backward and downward to expose the copper-foil seal (fig. 6-16). Discard the cap.

b. Remove the canister candle cover by rotating the swivel plate 180°. Push it down toward the center of the canister, as shown in view A of figure 6-17. Leave the cover dangling by the lanyard, as shown in view B of figure 6-17. When you remove the candle cover, do NOT pull the lanyard so that the cotter pin is removed. The removal of the cotter pin fires the candle, and the canister starts generating oxygen. If this happens while the copper-foil seal is intact, internal pressure in the canister will build up. This pressure will cause the copper foil seal or the canister seam to rupture.

c. Hold the canister with the neck up and the concave, or ribbed side, toward your body. Insert the canister upward into the guard and breastplate assembly (fig. 6-18) until the canister is firmly in place. The canister is now locked in a standby position with the copper-foil seal still intact. If the copper-foil seal is pierced when the canister is placed in the standby position, the standby stop will need to be adjusted. An OBA that pierces the copper-foil seal in the standby position is NOT to be used until the adjustments are made.

7. Don and adjust the facepiece as follows:

a. Place the head harness straps over the front of the facepiece.

b. Insert your chin into the chin stop of the facepiece (view A of fig. 6-19).

c. Pull the head straps from the front of the facepiece over your head (view B of fig. 6-19). Be sure your hair is not under the facepiece shield.

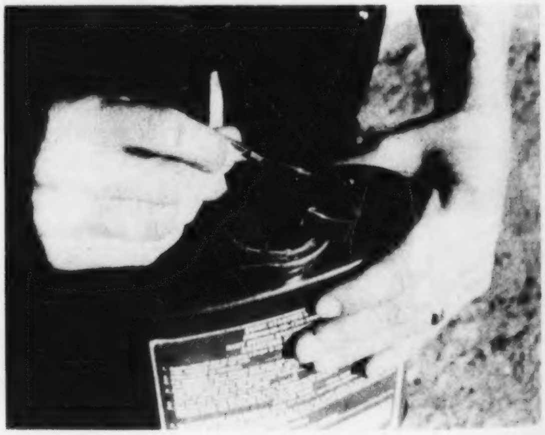
d. Make sure the straps lie flat against your head.

e. Tighten the lower straps (neck straps) first.

f. Tighten the side straps.

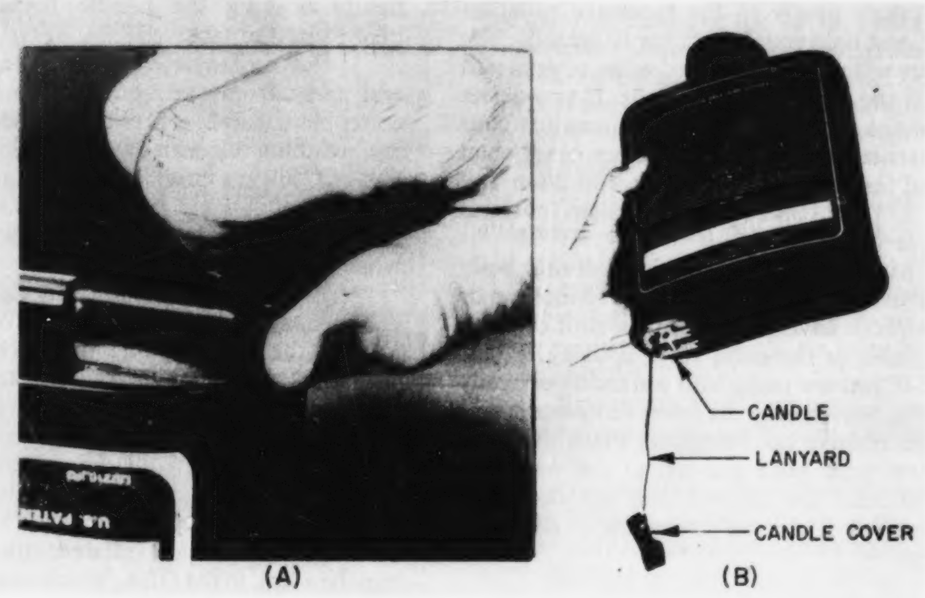
g. Place both hands on the head harness pad (on the back of your head) and push it down toward your neck.

h. Repeat steps e and f.



285.11.5

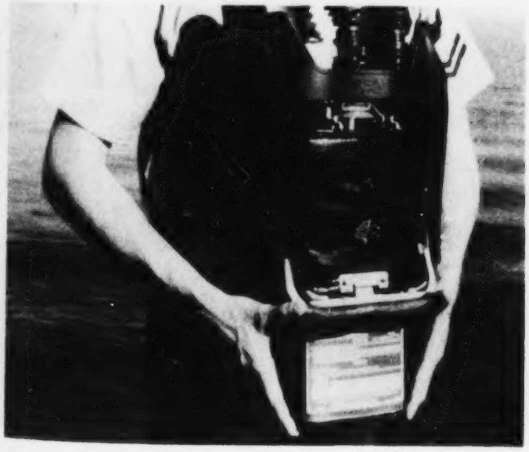
Figure 6-16.—Step 6 removing tear-off cap.



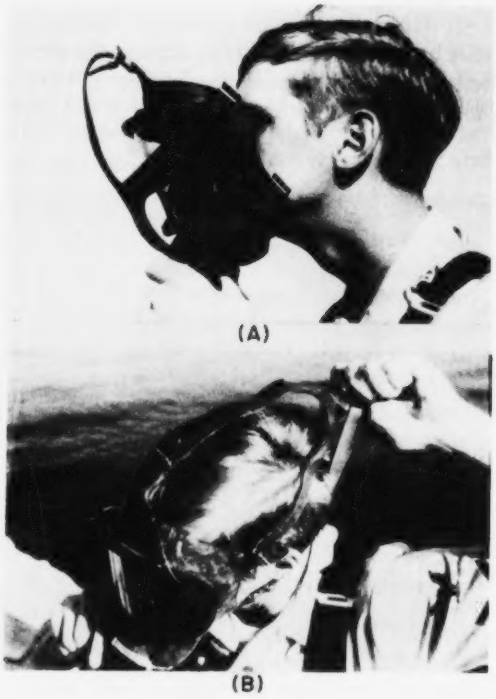
285.12
Figure 6-17.—Removing the candle cover, views A and B.

i. Tighten the forehead or front strap, if needed.

8. Test the facepiece for a good seal by squeezing the corrugated breathing tubes tightly to prevent the passage of air (fig.



285.13
Figure 6-18.—Inserting the canister.



285.14
Figure 6-19.—Donning the facepiece, views A and B.

6-20). Inhale gently so the facepiece collapses slightly, and hold your breath for 10 seconds. The facepiece will remain collapsed while your breath is held if the assembly is gas tight. If you detect any leakage around the face seal, readjust your head harness straps. If you detect other than face-seal leakage, investigate the condition and correct it. You MUST test the facepiece for a seal before each use.

9. Make final adjustments on all four body harness straps. You should be able to look up or down without having the facepiece shift or catch on the timer or the main valve housing.

10. If you are going into a standby or ready condition, loosen only the lower facepiece straps and then remove the facepiece. Place the facepiece over your head and out of the way until ready to start the canister and put the OBA into operation. In an emergency, eliminate this step.

STARTING THE CANISTER.—When you are ready to enter the contaminated area, start the canister in the following manner:

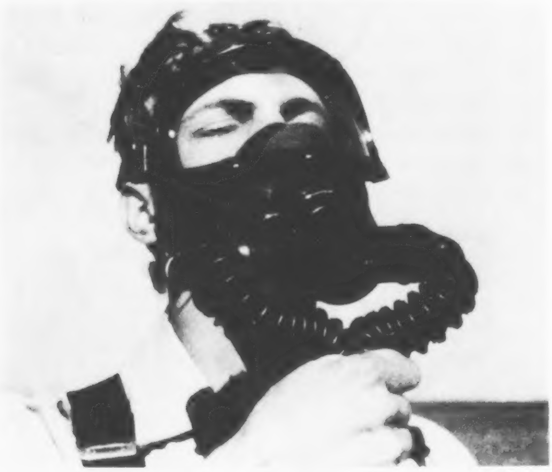
1. If your facepiece is in the standby position, put it on before starting the canister. Retighten the lower straps and retest your facepiece for a proper seal.

2. Unlock the bail assembly handle of the OBA by using both hands to depress the tabs from the bottom lock. Swing the handle upward until it snaps. Test the handle to see if it is locked by lightly pushing the handle forward without depressing the tabs.

3. Pull the lanyard on the canister straight out and away from your body. This removes the cotter pin (fig. 6-21), fires the candle, and inflates the breathing bag with oxygen. After you pull the lanyard, always check to ensure that the cotter pin is still attached to the lanyard. A slight amount of harmless smoke may be present in the facepiece while the candle is burning.

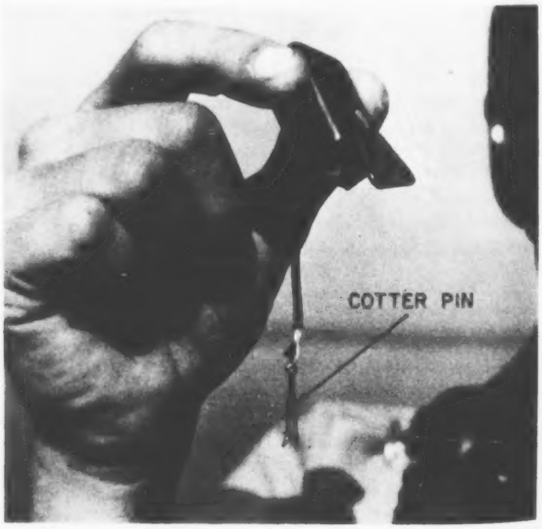
4. Now, test the tube connectors, canister, and breathing bags for tightness. While the candle is filling the breathing bag, depress the breathing bag at the pull tab with your left hand. Regrasp and seal off both breathing tubes with your right hand, while pressing against the right side of the breathing bag with your right elbow (fig. 6-22). The bag must be compressed at the pull tab so that the relief valve does not vent during this test. The bag must remain inflated; otherwise, there may be a leak in the OBA, which you must correct before you use the OBA.

5. Breathe normally. The chemical reaction of the canister will generate more oxygen than you require. If too much oxygen is produced, the extra oxygen will be vented automatically by the relief valve in the bag when the bag reaches full capacity. A manual relief pull tab on the valve (fig. 6-23) is provided in case the valve sticks in the closed position during a long period of storage. DO NOT pull the breathing bag tab



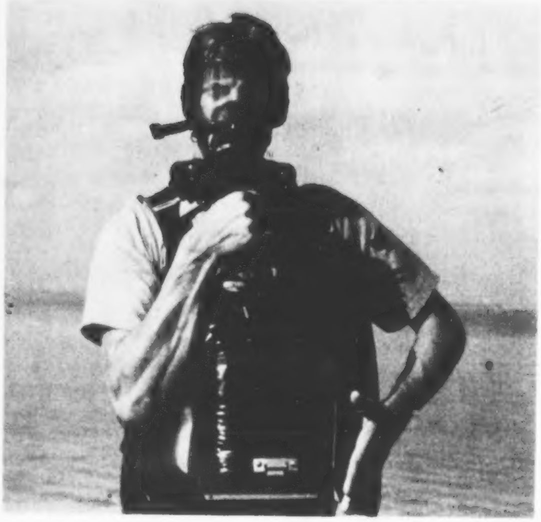
285.15

Figure 6-20.—Airtightness of the facepiece.



285.16

Figure 6-21.—Checking for the cotter pin.

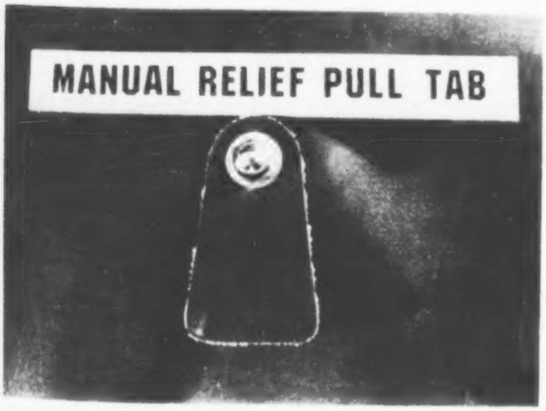


285.17

Figure 6-22.—Testing the OBA.

during normal use. If you do, you will vent your breathing oxygen from the breathing bag to the atmosphere.

In the event of a malfunction of the candle, you can activate the canister manually. The manual starting of the canister is not recommended. The procedures listed here are to be used only when the chlorate candle has misfired and sufficient time is available to start the canister manually, or if there is a shortage of available canisters. Under no circumstances should you save the chlorate candle to use for an emergency exit of the space. Such practice is dangerous, and the candles have been known to misfire.



285.18

Figure 6-23.—Manual relief valve tab.

You must be in a clean atmosphere when manually starting the canister. Use the following procedures:

1. Work one finger under the edge of your facepiece, stretching the mask slightly to break the seal.
2. Inhale while grasping and squeezing both breathing tubes with your other hand. This will allow you to draw external air from outside the facepiece.
3. Release the breathing tubes, remove your finger to reseal the mask, and exhale into the facepiece.
4. Continue this cycle until your breathing bag is fully inflated. Exhaust the air in the breathing bag by exerting pressure on the right-hand side until the bag on the right is deflated. In this process, your moist breath passes through the canister to start the chemical reaction. One filling of the bag is not usually sufficient to fully activate the canister.
5. Repeat steps 1 through 4 to reinflate and deflate the breathing bag at least five times. Now, without gloves, cautiously feel the bottom of the canister. If the entire bottom of the canister is warm, oxygen is being generated. The apparatus is then ready for setting the timer and for the operational check. If the canister is not warm, repeat steps 1 through 4. In cooler temperatures, several cycles of inflation and deflation of the bag may be required to start oxygen production.

SETTING THE TIMER.—To set the timer, grasp the knob on the timer. Turn the knob clockwise to 60 minutes, and then turn it counterclockwise to 30 minutes. By setting the timer to 60 first, you fully wind the alarm bell spring. When 30 minutes have expired, the warning bell will sound continuously for 10 or more seconds. When you have set the timer, you are ready to enter a hazardous atmosphere.

REMOVING AN UNUSED CANISTER.—If the canister's copper-foil seal has not been punctured, remove the canister by placing one hand on the bottom of the canister and pulling the canister releasing strap. You do not need to wear gloves in this situation. The handle must also be in the load and standby positions.

Once the canister is removed, protect the copper-foil seal by installing one of the spare aluminum caps that are provided for this purpose.

REMOVING A USED CANISTER.—When you remove a hot canister, you need to protect your hands with approved protective gloves.

Once the canister has been used, remove the facepiece and put it over your head in the standby position. Then, unlock the handle from the operation position and swing it down to the load and standby positions.

Next, unfasten the waist strap, spread your feet apart and lean the upper part of your body slightly forward. To release the used canister, pull the canister release strap (fig. 6-24). The canister will drop out of the apparatus (fig. 6-25). Drop the canister ONLY on a clean, dry deck.

You need to be careful when you remove used canisters from the OBA. They are hot, and the chemicals inside of the canister can cause serious chemical burns if they get on your skin. The chemicals are similar to caustic soda, also known as lye. Normally, you will not have chemicals spilling out of the canister, but there is always the possibility. Finally, the chemicals will cause a violent explosion if they come into contact with a petroleum-base substance.

DISPOSAL OF USED CANISTERS.—You must dispose of an OBA quick-starting canister as soon as possible after it has been used or when the copper-foil seal has been punctured.

If your ship is more than 25 nautical miles from shore, you may throw the canister overboard. To dispose of the canister in this manner, first obtain permission from the officer of the deck. Once permission has been granted, ensure that the canister cap is removed and the copper-foil seal is fully punctured. This will allow water to enter the canister. DO NOT puncture holes in the bottom or sides of the canister. Make sure there is no oil in the water. Then throw the canister overboard. If oil gets inside of the canister, a violent explosion will occur.

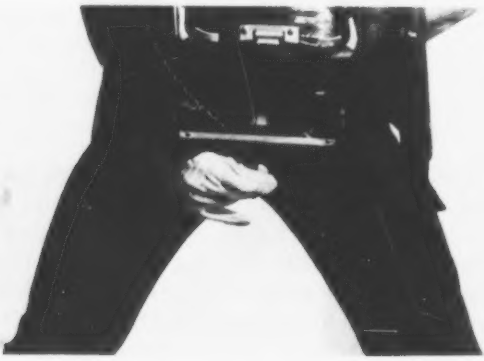


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Figure 6-24.—Releasing the canister.

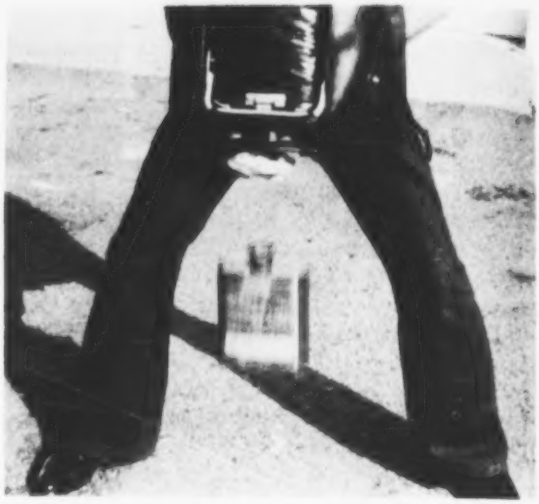

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Figure 6-25.—Dropping the canister.

If you are within 25 nautical miles of shore, do not throw the canister overboard. Instead, let it cool down for at least 30 minutes. (If a canister was not used, but the copper-foil seal has been punctured, place the canister in a clean bucket. Light off the canister and let it set for 15 minutes to cool.) When the canister is cool enough to handle, place a new metal cap, NSN 4240-00-089-7963, on the neck to cover the punctured copper-foil seal. Then double wrap the canister in a poly bag, NSN 8105-00-299-8532, or its equivalent. The wrapped canister should then be stored in a dry, oil-free area until it can be disposed of at sea or turned over to a shore facility for disposal.

When the ship is in port, contact the department ashore that is responsible for hazardous waste. Make arrangements with that department to turn all canisters over to them for disposal.

REMOVING THE OBA.—Remove the OBA in the following manner:

1. Remove the facepiece by releasing the head straps at the buckles with your fingertips before pulling the headpiece off. If the canister is still in the OBA, place the facepiece over your head

in the standby position and remove the canister. NEVER remove the OBA with a canister in place.

2. If the facepiece is in standby position, you should remove it and let it hang in front of the OBA.

3. Loosen the waist strap, then unhook it.

4. Loosen the shoulder straps and unhook the harness at the upper corners of the breastplate assembly. Grasp the facepiece and operating handle with one hand and the shoulder harness (preferably at the D-ring connector) with your other hand. Lift the OBA over your head.

5. If the OBA is wet or moist, wipe it down.

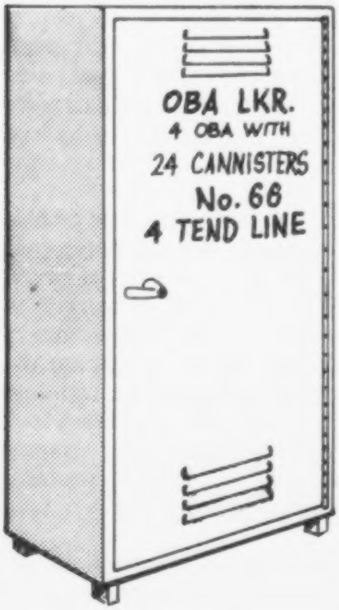
6. Always clean the outside body of the OBA after each use with a mild solution of soap and warm water.

7. Disinfect the inside of the facepiece. Mix the disinfectant (NSN 95-6840-00-526-1129) as stated on the container label. Use a sponge that is moist, but not dripping, with the disinfectant solution.

OBA Equipment Stowage

Before stowing the OBA, the facepiece should be protected to prevent scratches and abrasions. All OBA equipment and canisters must be stored in a cool, dry place. The life of an OBA will be lengthened if it is stored under these conditions. The term *cool* denotes temperatures ranging from above freezing to 110 °F (43 °C) when storage is out of direct sunlight. The term *dry* usually denotes a storage area where condensation does not come in contact with the equipment.

The only places the OBA should be stowed onboard ship are in repair lockers or in OBA lockers (fig. 6-26). These lockers have provisions for stowing the OBA in a flat position. You should ensure that the facepiece is properly protected to prevent scratching or scarring of the lens. The canisters should be stowed with the concave side down. Additional information on cleaning, inspecting, and testing of the type A-4 OBA can be found in the *Naval Ships' Technical Manual*, chapter 079, volume 2.



285.22

Figure 6-26.—OBA storage locker.

TENDING LINES

Tending lines are used as a precautionary measure to help rescue an investigator or fire fighter who is wearing an oxygen breathing apparatus, air-line mask, or similar equipment.

A 50-foot nylon covered, steel wire tending line (fig. 6-27) is used aboard ship with the oxygen breathing apparatus or the air-line mask. The tending line has a stout hook on each end that is closed with a snap catch. The line is pliable and can slide freely around obstructions.

If necessary, the rescue should be accomplished by having another person equipped with a breathing apparatus follow the tending line to the person to be rescued. Do not attempt to drag the person out by the tending line. The line may become fouled on some obstruction or part the wearer's harness. This will mean a loss of time,

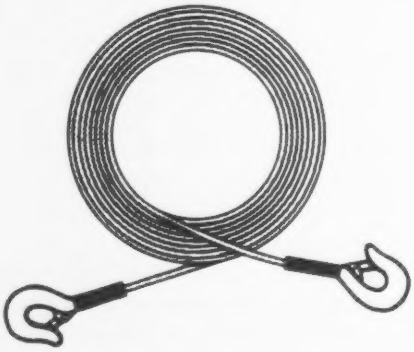


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Figure 6-27.—Tending line.

and it will still be necessary to send another person in. If the rescue is to be effected promptly, someone must be equipped with an OBA that is ready for immediate use and must be standing by ready for immediate entry. Tending lines may also be used by fire fighters to find their way back to fresh air to change canisters when the visibility is poor because of heavy smoke.

When the OBA is used to inspect damage or to fight fires, a team of one wearer and one person to handle the tending line should work together. If two or more OBAs are used in the same compartment, the tending lines are not used. However, the personnel wearing the OBAs should keep in constant sight or touch with each other.

The OBA wearer and the line tender should both know and use the following system of line signals

Code	Pull	Meaning
O	1	OK
A	2	Advance
T	3	Take up
H	4	Help

CAUTION

A stricken person must never be hauled by a line attached to the waist. A person may be dragged by the waist a short distance along the deck, but his/her weight must never be suspended from the waist. If the wearer lacks any sort of shoulder harness, the line must be made fast so that it passes around the upper part of the body and under the arms, and meets either in front or the back. The tender should wear rubber gloves and shoes when handling steel tending lines or cables.

OBA TRAINING CANISTER KIT

The OBA training canister kit—FSN 2H-4240-00-238-9959—(fig. 6-28) is designed to provide realistic training in the classroom for 40 trainees. These trainees don the OBA and properly activate the quick-start OBA (training) canister. The training canister is red in color and is functionally identical to the regular green quick-start canister. However, there is one important distinction: The training canister contains a chemical filler (baralyme), which only absorbs the carbon dioxide (CO_2) from exhaled breath. It does not produce oxygen. There is enough baralyme to absorb the CO_2 that will be exhaled by the 40 trainees who use the canister for 5 minutes each AT REST.

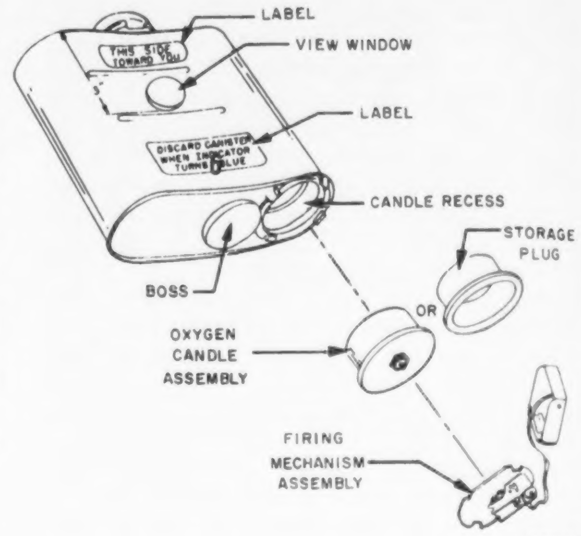

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Figure 6-28.—Training canister assembly—exploded view.

NOTE: The canister should be discarded after it is used by 40 trainees, or when the chemical in the view window of the canister body changes color from pink to solid blue, whichever occurs first.

The oxygen candle assembly produces about 10 liters of oxygen. In the training canister, this is enough to provide 5 minutes of oxygen for one person AT REST. The danger of a training canister being used during an actual casualty is obvious. To prevent inadvertent use and possible serious injury or a fatality, the training canisters should NEVER be stowed in OBA lockers or in the vicinity of damage control equipment.

For the initial charging of a training canister, use the following procedures:

1. Remove the cover from the firing mechanism. Remove the firing mechanism and storage plug. Save the plug to reuse when storing a partially used canister to prevent moisture from entering the canister body.

2. Insert a candle assembly into the candle recess of the canister. Make sure the gasket is flat against the bottom of the canister.

3. Place the firing mechanism over the candle assembly with the primer housing projecting through the center hole and with the notches lined up with the tangs. The notches and tangs are positioned so that the unit can only be assembled in the correct position.

4. Rotate the firing mechanism clockwise to lock the candle in place. Tighten the firing mechanism until the frame contacts the tangs. Do not overtighten.

5. Fold the lanyard into the candle cover and secure the assembly on the firing mechanism frame. The training canister is now ready for use with the OBA.

To recharge a canister that has just been used, use the following procedures:

1. Position and secure a new metal tear-off cap on the canister neck so that the tab points toward the instruction label on the convex side of the canister.

2. Remove the firing mechanism from the bottom of the canister by turning it counterclockwise until the tangs line up with the notches.

3. Remove the used candle and place it in a regular trash can after it has cooled.

4. Hold the firing mechanism (fig. 6-29) with the slotted end of the frame pointing toward you. Raise the firing hammer to the cocked position.

5. While holding the firing hammer in the cocked position, insert the cotter pin through the holes in the frame from the same side as the rivet head. Secure the cotter pin by bending the long leg slightly.

The remainder of the recharging procedure is the same as steps 2, 3, 4, and 5 of the initial charging procedure.

To start a training canister after it has been charged, use the following procedures:

1. Remove the tear-off cap from the top of the CHARGED canister by pulling it straight backward and downward; remove the disk to expose the gasket.

2. Remove the candle cover by rotating the swivel plate 180°; push the swivel plate and cover down toward the center of the canister. Let the cover dangle on the lanyard. DO NOT PULL THE LANYARD.

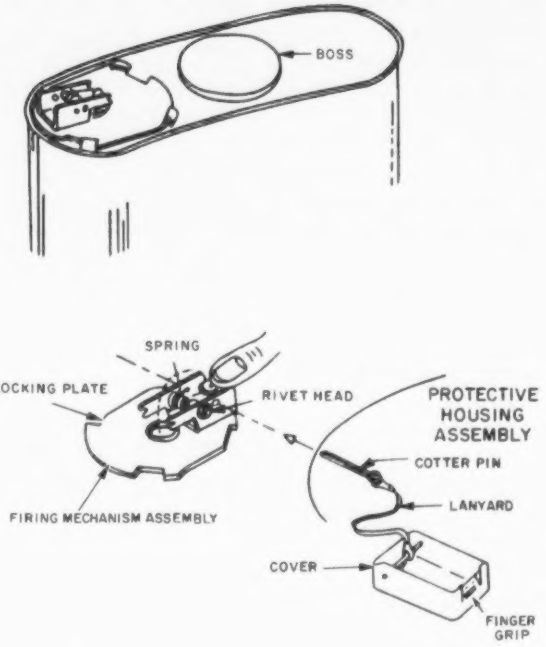

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Figure 6-29.—Detailed assembly of firing mechanism.

3. Insert the training canister into the OBA to the standby position.

4. Move the training canister into the operating position by lifting the handle upward, ensuring that the canister is snug in the canister guard.

5. Don and adjust the facepiece, and check it for an airtight fit.

6. Pull the lanyard straight out away from your body. This removes the cotter pin and fires the candle, which inflates the bag with oxygen within 15 seconds.

7. Set the timer on the OBA by turning it clockwise to 60; then, return it to 5.

To remove the canister, you should follow the same procedures used for removing an unused canister (discussed earlier in this chapter). However, you must wear protective gloves because the canister will be hot. If the canister is to be reused by another person, charge it as previously discussed.

Training Kit Stowage

Training canister kits are to be stowed in a special locker provided or in a locked compartment. This kit is to be kept locked at all times, except when it is in actual use. The keys should be controlled by the damage control officer to ensure that the training canisters are used only for training.

After training sessions or for breaks in training of 1 hour or more, a partially used canister should be sealed. To seal the canister, place a metal tear-off cap on the canister neck, remove the oxygen candle, and lock the plastic storage plug in the candle recess in the canister bottom by the firing mechanism. The canister should be returned to the special locker or compartment and locked. Where lockers are not provided, stow the canister in a cool, dry storeroom.

Training Kit Disposal

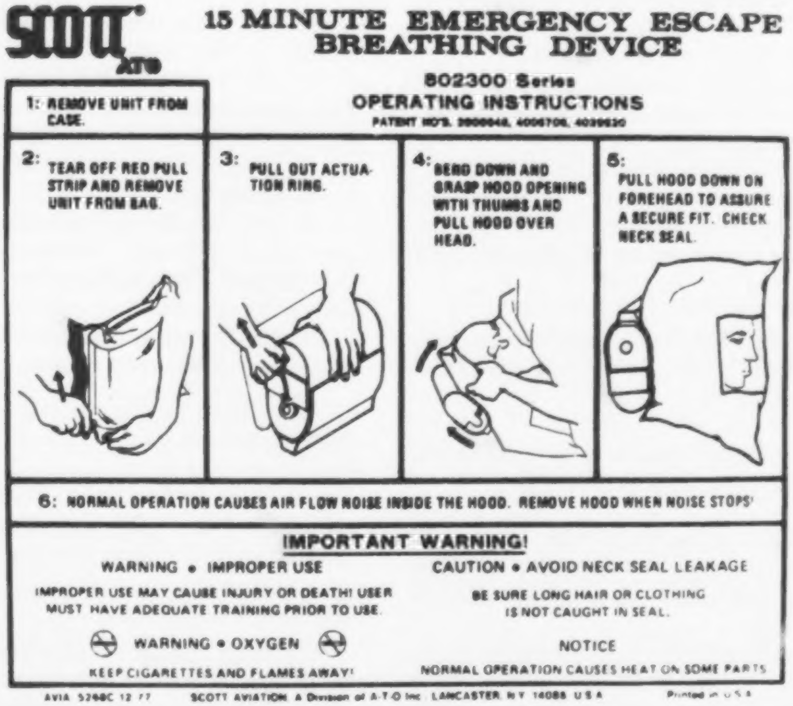
After the chlorate oxygen candles have been burned, they contain sodium chloride (table salt) and partially oxidized iron. They may be discarded in a regular trash container after they have cooled.

Expended training canisters do not have the hazards of the regular quick-start canister. However, for the training benefit, they should be disposed of in the same manner as the regular quick-start canister.

EMERGENCY ESCAPE BREATHING DEVICE

The emergency escape breathing device (EEBD) provides you with respiratory and eye protection in an atmosphere that will not support life. Studies have shown that most fire casualties are caused by smoke and toxic fumes and not by the fire itself. The EEBD was developed to provide a 15-minute supply of breathable air. It is to be worn until you can get topside during evacuation from below deck spaces.

Primary components of the EEBD are a protective hood and life-support pack. The hood contains the breathable air and has a large visor and an elastic neck seal to prevent contaminants from entering the hood. The hood is fire resistant and will protect your face from open flame for about 6 seconds. The life-support pack consists of a solid, chemical oxygen generator, CO_2 scrubber, and venturi nozzle. The EEBD is stored in a protective case, which has simple operating instructions on the outside and an attached carrying strap. The outside of the case has a tamper seal which allows you to see if the unit



15 MINUTE EMERGENCY ESCAPE BREATHING DEVICE

802300 Series
OPERATING INSTRUCTIONS
PATENT NO'S. 3906048, 4006706, 4039620

1: REMOVE UNIT FROM CASE.

2: TEAR OFF RED PULL STRIP AND REMOVE UNIT FROM BAG.

3: PULL OUT ACTUATION RING.

4: BEND DOWN AND GRASP HOOD OPENING WITH THUMBS AND PULL HOOD OVER HEAD.

5: PULL HOOD DOWN ON FOREHEAD TO ASSURE A SECURE FIT. CHECK NECK SEAL.

6: NORMAL OPERATION CAUSES AIR FLOW NOISE INSIDE THE HOOD. REMOVE HOOD WHEN NOISE STOPS!

IMPORTANT WARNING!

WARNING • IMPROPER USE
IMPROPER USE MAY CAUSE INJURY OR DEATH! USER MUST HAVE ADEQUATE TRAINING PRIOR TO USE.

CAUTION • AVOID NECK SEAL LEAKAGE
BE SURE LONG HAIR OR CLOTHING IS NOT CAUGHT IN SEAL.

WARNING • OXYGEN
KEEP CIGARETTES AND FLAMES AWAY!

NOTICE
NORMAL OPERATION CAUSES HEAT ON SOME PARTS

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Figure 6-30.—EEBD.

has been opened. When you need to use the EEBD, follow the instructions on the outside of the protective case (fig. 6-30).

With the proper training, you should be able to activate and don an EEBD in less than 30 seconds.

WARNING

REMEMBER, WHEN DONNING THE EEBD, IF YOU DON'T HEAR THE HISSING SOUND OF OXYGEN BEING GENERATED, DISCARD THE UNIT AND GET ANOTHER.

To remove the EEBD, grasp the hood at the lower edge of the back and pull it forward over your head. Be careful not to touch the life-support pack because it will be hot. Since the unit cannot be recharged after being used, it must be disposed of according to your ship's operating instructions.

Maintenance of the EEBD consists of a simple semiannual inspection to ensure that the device has not been tampered with, lost its vacuum seal, or exceeded its shelf life. A viewport on the side of the carrying case provides visual access to the humidity sensor. The humidity sensor indicates loss of the vacuum seal by a change in color from light blue to white or pink.

Remember, the EEBD is not to be used for fire fighting in place of the oxygen breathing apparatus (OBA). The EEBD was designed to be used only to save your life in emergency evacuation situations.

AIR-LINE MASKS

The air-line mask (fig. 6-31) is part of all ship's repair party locker allowance. The air-line mask

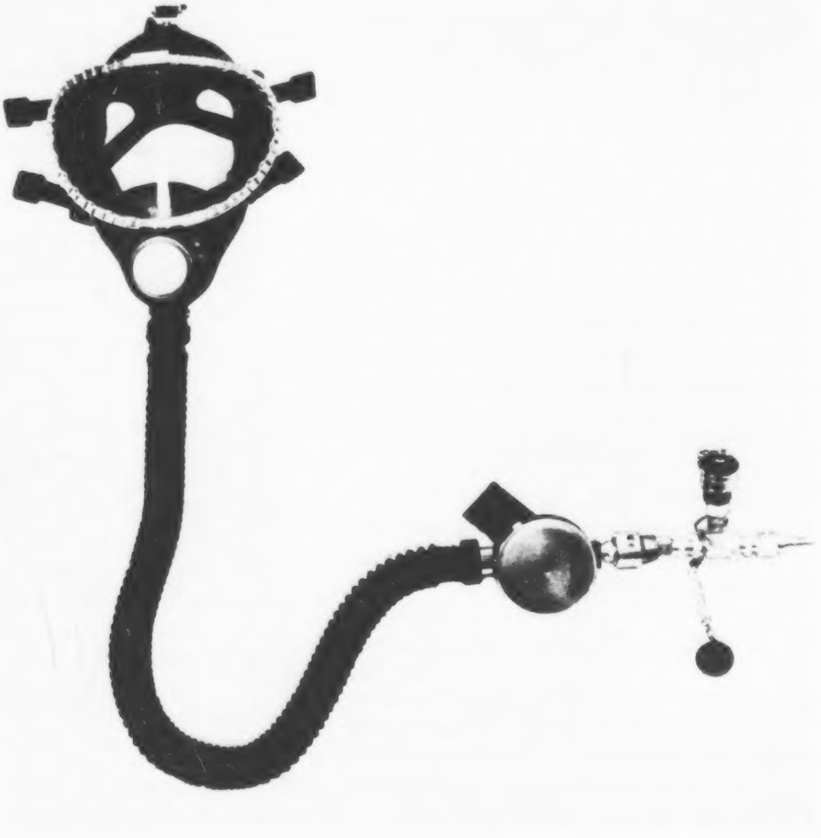

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Figure 6-31.—Air-line mask with buddy fitting.

MUST NOT be used to fight fires. However, it may be used to enter smoke-filled spaces to rescue personnel.

The air-line mask is a demand-flow, air-line respirator with a speaking diaphragm, monocular lens with adjustable head harness, breathing tube and belt-mounted demand regulator with male and female (buddy) quick-disconnect fittings. A 25-foot length of hose with male and female quick-disconnect fittings is provided for use with the air-line mask. This hose can be used to connect to the demand regulator fitting and a low-pressure air supply, or to a compressed air cylinder with an intervening air regulator and air filter. The air filter consists of a particulate element and a refillable charcoal cartridge.

A positive pressure of 30 to 125 psi must be maintained at the demand regulator at all times. The maximum length of hose that may be used with the air-line mask is 250 feet. If the compressor room's air is contaminated with smoke or other gases, secure the compressor and use another compressor that is in a compartment that has clean air. The hose is flammable and may get tangled up with wreckage. If the hose does get tangled, it could pull the mask off your face.

To use the air-line mask, follow these procedures:

1. Check the regulator on the compressed air cylinders, if used, to ensure that it is closed.
2. Open the valves on the cylinders, or connect the hose up to the low-pressure air system.
3. Open the regulator on the cylinders by turning the adjustment handle clockwise until the desired reading or rate of flow is obtained. DO NOT exceed 125 psi when using the compressed gas cylinders.
4. Don the safety belt.
5. Grasp the mask with both hands. Slip the facepiece on your chin first. Then adjust the head straps as follows:

   a. Ensure that the straps lie flat against your head.
   b. Tighten the lower (neck) straps.
   c. Tighten the side straps. Do not touch the forehead (front) strap.
   d. Place both hands on the head harness pad. Push the pad down toward your neck.
   e. Repeat steps b and c.
   f. Tighten the forehead strap.
   g. Test for a tight fit of the facepiece by squeezing the breathing tube and taking a deep breath. The facepiece must collapse against your face or be readjusted until it does.

6. Take a deep breath to ensure there is no blockage of the airflow.
7. Push the male quick-disconnect fitting into the female fitting of the manifold.
8. Inhale deeply to ensure there is a sufficient airflow.
9. If you are forced to evacuate a space, you can do so by disconnecting the female portion of the quick-disconnect fitting and leave the air-line mask on. The female fitting is equipped with an automatic shutoff. Therefore, it is not necessary to secure the low-pressure air system or the cylinders when making an emergency evacuation of the space.
10. When leaving a smoked-filled space without any type of respiratory equipment other than the air-line mask, get as close to the exit as possible. When you run out of hose, take a couple of deep breaths, hold your breath, disconnect the female quick-disconnect fitting, and exit the space immediately.

Do not remove the mask until you are out of the smoke-filled space.

Further information on the air-line mask is available in the *Naval Ships' Technical Manual*, chapter 079, volume 2.

PROXIMITY FIRE-FIGHTING SUIT

The proximity fire-fighting suit (fig. 6-32) provides you with thermal protection while you approach and operate close to large fires. It also allows you to enter overheated or steam-filled compartments to bring fires under control, conduct a rapid investigation after the fire is under control, and to rescue aircraft personnel when a crash fire occurs. It cannot be used to move through flames or through burning liquid fuels.

The proximity fire-fighting suit consists of a two-piece pants and coat outfit, gloves, a hood, and boots. The hood provides a covering over the oxygen breathing apparatus when it is worn. The material used in the pants and coat, gloves, and hood is asbestos cotton, aluminized on the outside for reflective purposes. The boots are rubber. The proximity suit also resists the penetration of liquids.

ATMOSPHERE TESTING DEVICES

All closed or poorly ventilated compartments, particularly those in which a fire has just occurred,

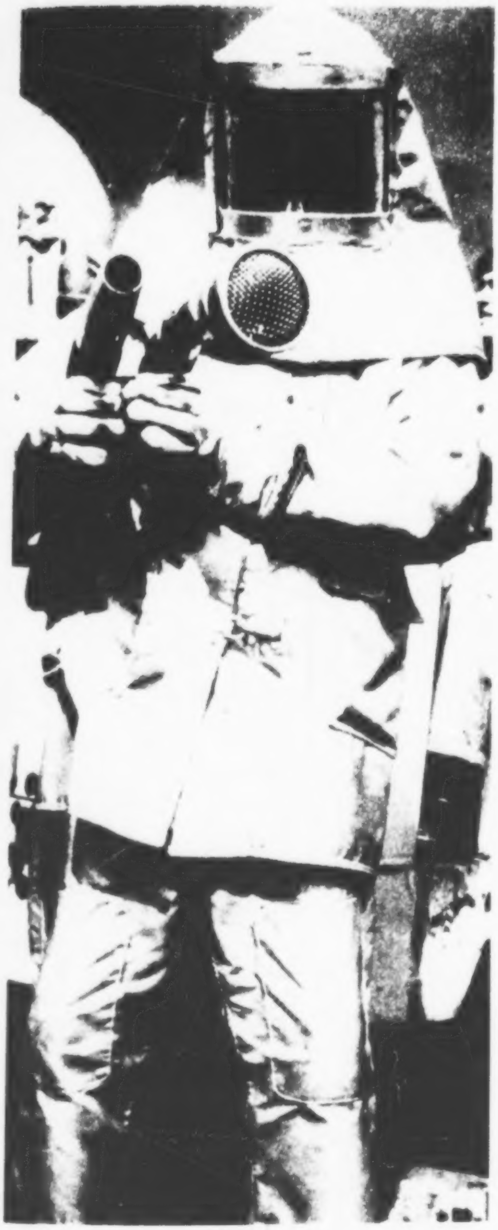

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Figure 6-32.—Proximity suit.

are potentially dangerous. The atmosphere may lack oxygen, contain poisonous gases, or present fire and explosion hazards.

Aboard naval ships, no person may enter any closed compartment or poorly ventilated space until the ship's gas-free engineer, or his authorized representative, has tested the space and declared that it is safe to enter. Before entering, you must comply with all applicable safety and entry precautions. Also, the danger of poisoning, suffocation, ignition of flammable materials, or gases must be eliminated or reduced to the lowest practicable minimum.

No job involving hot work, such as welding, cutting, or grinding may be done aboard naval ships until the gas-free engineer, or his authorized representative, has inspected the place where the work is to be done and declared that the applicable safety and entry precautions have been complied with. Also, the space needs to be certified as safe for personnel to work in the area without danger of poisoning or suffocation and that hot work can be undertaken without danger of fire or explosion.

As a Damage Controlman, you may be assigned to act as an authorized representative of the gas-free engineer. Therefore, it is very important that you have a thorough knowledge of the equipment used on your ship to test the atmosphere in closed or poorly ventilated compartments. Some of the equipment you will be working with are the oxygen analyzers, combustible gas indicators, and toxic gas detectors.

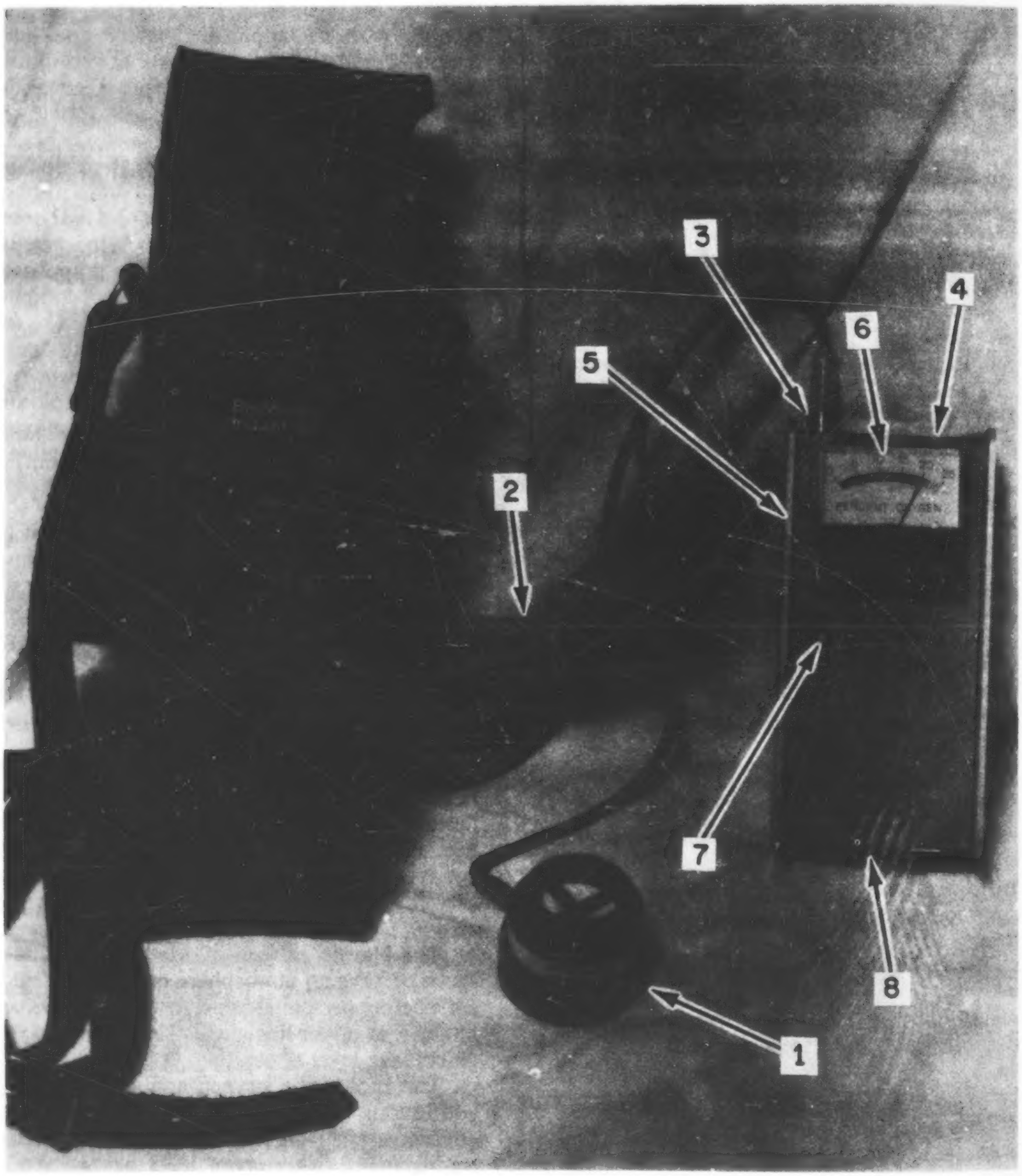
OXYGEN ANALYZER

The oxygen analyzer is used to verify the percentage of oxygen within a space. Several models, manufactured by different companies, are used throughout the Navy. One model commonly used in the Navy is the BioMarine Model OA225R (fig. 6-33) which is described below.

The Navy's Bureau of Medicine requires a space to have an atmosphere oxygen content of 20% before personnel can enter the space without an OBA or an air-line mask. The normal oxygen percentage level at sea level is 20.8%.

The BioMarine oxygen analyzer provides a continuous reading of the oxygen content concentration from 0% to 25% oxygen in any environment. An oxygen level below 20% or above 22% should be considered as a potentially dangerous situation. If the oxygen content is less than 20% the space should be ventilated and then retested.

The BioMarine oxygen analyzer requires oxygen to operate. Batteries are not required to operate this instrument. Once the sensor package is opened, the sensor's life is about 1 year if the rubber plug is reinstalled after each use.



1. Remote oxygen sensor on remote cord with integral plug
2. 15ft. cord integral with sensor assembly
3. Chassis jack for remote sensor
4. Label position for calibration instructions
5. Chassis Wrap
6. 0-25% meter
7. Calibration Pot
8. Chassis

8.499

Figure 6-33.—BioMarine Oxygen Indicator Model OA225R.

The oxygen analyzer should be calibrated before each use. To calibrate the instrument, expose the sensor to fresh air on the weather deck. A calibration screw is located below and to the left of the meter. Use a screwdriver and rotate the calibration screw clockwise until the meter reads more than 22%. Then turn the calibrating screw counterclockwise until the meter reads 21%. If the meter can not be adjusted to read more than 22%, the sensor is getting near the end of its operating life and must be replaced. Do not throw the instrument away. You can order replacement sensors through your normal supply channels.

To operate the oxygen analyzer, use the following procedures:

1. Insert the remote sensor cord connector in the top of the metal meter case. Turn the connector clockwise three-fourths of a turn to lock it in place.
2. Remove the rubber discard plug from the sensor face. Do not throw the rubber discard plug away; you will need to replace it later.
3. Calibrate the oxygen analyzer as described above.
4. Send the sensor into the space to be tested and check all around the compartment. The person inside the space with the sensor must wear an OBA or an air-line mask. Observe the meter constantly while conducting the test. Make a note of the lowest reading you get.
5. Upon completion of your tests, flush the instrument with fresh air.
6. Reinstall the rubber discard plug on the sensor.
7. Disconnect the remote sensor cord from the metal meter case.
8. Store the oxygen analyzer in a clean, dry area.

COMBUSTIBLE GAS INDICATORS

The combustible gas indicator is an instrument used to detect various flammable gases and vapors. Combustible gas indicators are made by several manufacturers. Although they all operate on the same general principles, they vary in certain details. Each indicator is accompanied by a complete set of operating and maintenance instructions. In addition, a condensed operating routine is attached to the inside of the case cover. Before using any combustible gas indicator, read the instructions carefully.

A combustible gas indicator employs a heated platinum-wire filament associated with a Wheatstone bridge or modified potentiometer-type circuit. The combustible gas indicator can quickly, safely, and accurately detect all combustible gases or vapors associated with fuel oils, gasoline, alcohol, acetone vapors, illuminating gas, fuel gas, hydrogen, and acetylene in mixtures with air or oxygen. The indicator can detect small quantities of these gases or vapors up to the lower explosive limit (LEL). It gives a reliable indication of the mixture if it is in the upper explosive range or beyond the upper explosive limit. The higher and lower explosive limits define the range of a concentration of a material, expressed in the percent in the air, that will burn or explode if ignited. The LEL is the minimum percent by volume of a gas that, when mixed with air at normal temperature and pressure, will form a flammable mixture. The higher explosive limit (HEL) is the point at which an explosion is certain. The combustible gas indicator does not identify combustible gas or gases; it merely indicates that one or more combustible gases are present in a certain proportion.

The combustible gas indicator is provided with flame arresters to prevent flashbacks. The three combustible gas indicators you will be concerned with are the Navy type E, the Model GN type E, and the Model 40.

Navy Type E Combustible Gas Indicator

The Navy type E combustible gas indicator (fig. 6-34) has a scale of 0% to 100% LEL. The

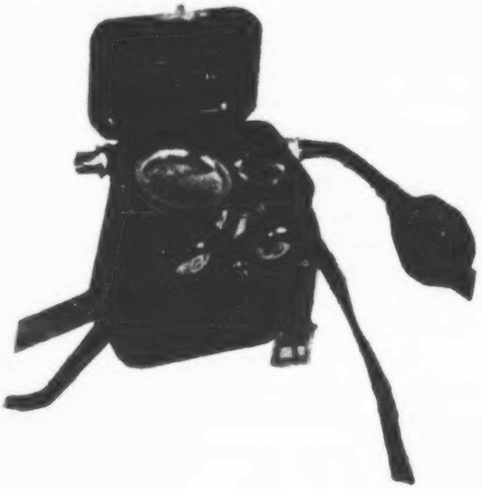


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Figure 6-34.—Combustible gas indicator, Navy type E.

scale is color-coded red above the 60% mark to readily indicate dangerous gas concentrations. Use the following procedures to operate this combustible gas indicator.

1. Open the cover to expose the rheostat knob and the indicator panel.
2. Connect the amount of sampling hose that you will need.
3. Lift the left end of the rheostat knob ON-OFF bar and turn the rheostat knob one-quarter of a turn clockwise.
4. Flush the combustible gas indicator with fresh air by squeezing the aspirator bulb five times. Squeeze the aspirator bulb another two times for each 10 feet of sampling hose that is connected to the indicator.
5. Adjust the rheostat knob until the meter pointer rests at the zero mark on the scale. If the needle stays to the left of the zero mark with the rheostat knob turned completely to the clockwise direction, the batteries are weak and need to be replaced. Six D-cell batteries (BA-30) are required to operate this indicator. If the needle moves completely to the right of the scale and cannot be adjusted to the zero mark, the detector filament is burned out and needs to be replaced. A spare detector filament is located under the indicator panel.
6. Place the end of the sampling hose inside the space to be tested.
7. Readjust the meter pointer to zero if necessary.
8. Squeeze the aspirator bulb five times for the indicator and two times for each 10 feet of sampling hose being used. Continue checking various locations within the space until the space is determined to be safe or a gas concentration is located. If a gas concentration is detected, continue checking and note where the highest reading is obtained.
9. Flush the unit in fresh air by squeezing the aspirator bulb five times for the indicator and two times for each 10 feet of sampling hose used.
10. To secure the indicator, turn the rheostat knob counterclockwise until the arrow on the knob points to the OFF position. The locking bar will drop into position in its slot. This indicates that the rheostat is in the OFF position.
11. Secure the cover.

Model GN Type E Combustible Gas Indicator

The Model GN type E combustible gas indicator (fig. 6-35) has a scale of 0% to 100% LEL. The scale is color-coded red above the 60% mark to readily indicate dangerous gas concentrations. Use the following procedures to operate the combustible gas indicator:

1. Attach the necessary amount of sampling hose.
2. Open the hinged cover panel and turn the ON-OFF switch to ON.
3. Depress the VOLT TEST switch with your left hand and note the reading on the indicating meter. The meter pointer should point directly to the SET VOLTAGE mark on the meter scale. To adjust the voltage, lift the voltage adjustment knob, and rotate the knob until the meter pointer points to the SET VOLTAGE mark. If the meter pointer stays to the left of the mark after complete clockwise rotation of the knob, replace the batteries. Eight D-cell batteries (BA-30) are required.
4. Pump the aspirator bulb several times to clear any residual gas from the indicator. Make sure that you are in a gas-free atmosphere when clearing the indicator.
5. Lift the ZERO ADJUST KNOB and rotate the knob each direction. Make the meter pointer move up and down the scale several times. Then adjust the ZERO ADJUST KNOB until the meter pointer reads zero on the scale.
6. When you are ready to take a sample, insert the sampling hose into the space being checked. Squeeze the aspirator bulb three or four times for the indicator and three times for each 5 feet of sampling hose used.

The meter pointer will fluctuate while you squeeze the aspirator bulb. If there is a gas

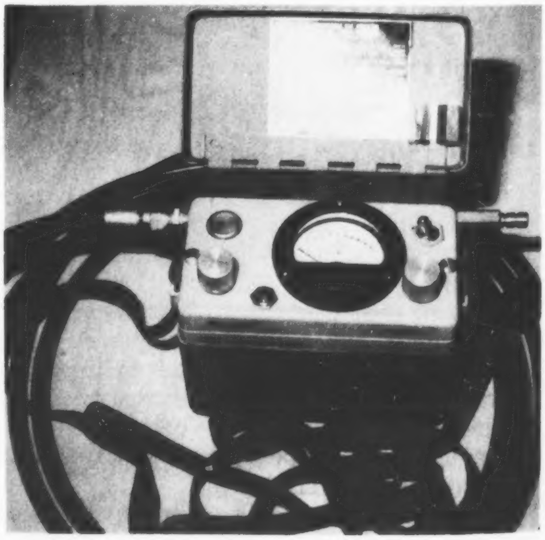

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Figure 6-35.—Model GN type E combustible gas indicator.

concentration present, the meter pointer will indicate the percentage. Clear the indicator in a clean atmosphere after each reading by squeezing the aspirator bulb until the meter pointer returns to zero on the scale. The indicator ON-OFF switch will return to the OFF positions when you shut the cover.

Model 40 Combustible Gas Indicator

The Model 40 combustible gas indicator (fig. 6-36) has two scales. One scale reads from 0% to 100% of the lower explosive limit. The other scale reads from 0% to 10% of the LEL full scale. A selector switch allows you to quickly change from one scale to the other. Use the following procedures to operate this indicator:

1. Open the cover.
2. Connect the sampling hose required and place the intake end of the hose in fresh air.
3. Turn the selector switch to CHECK.
4. Pull up on the VOLT ADJ knob and turn it all the way over to the left.
5. Pull straight up on the SW knob. The meter pointer should move towards the CHECK position on the scale.
6. Flush the indicator with fresh air. Squeeze the aspirator bulb 10 to 12 times to flush the indicator. Squeeze the aspirator bulb another two times for each 10 feet of sampling hose being used.
7. Adjust the meter pointer to zero. To make this adjustment, pull up on the VOLT ADJ knob and turn it in the direction that the meter pointer needs to go to reach the CHECK position on the scale. The VOLT ADJ knob has to be in the up position to make this adjustment. If you cannot

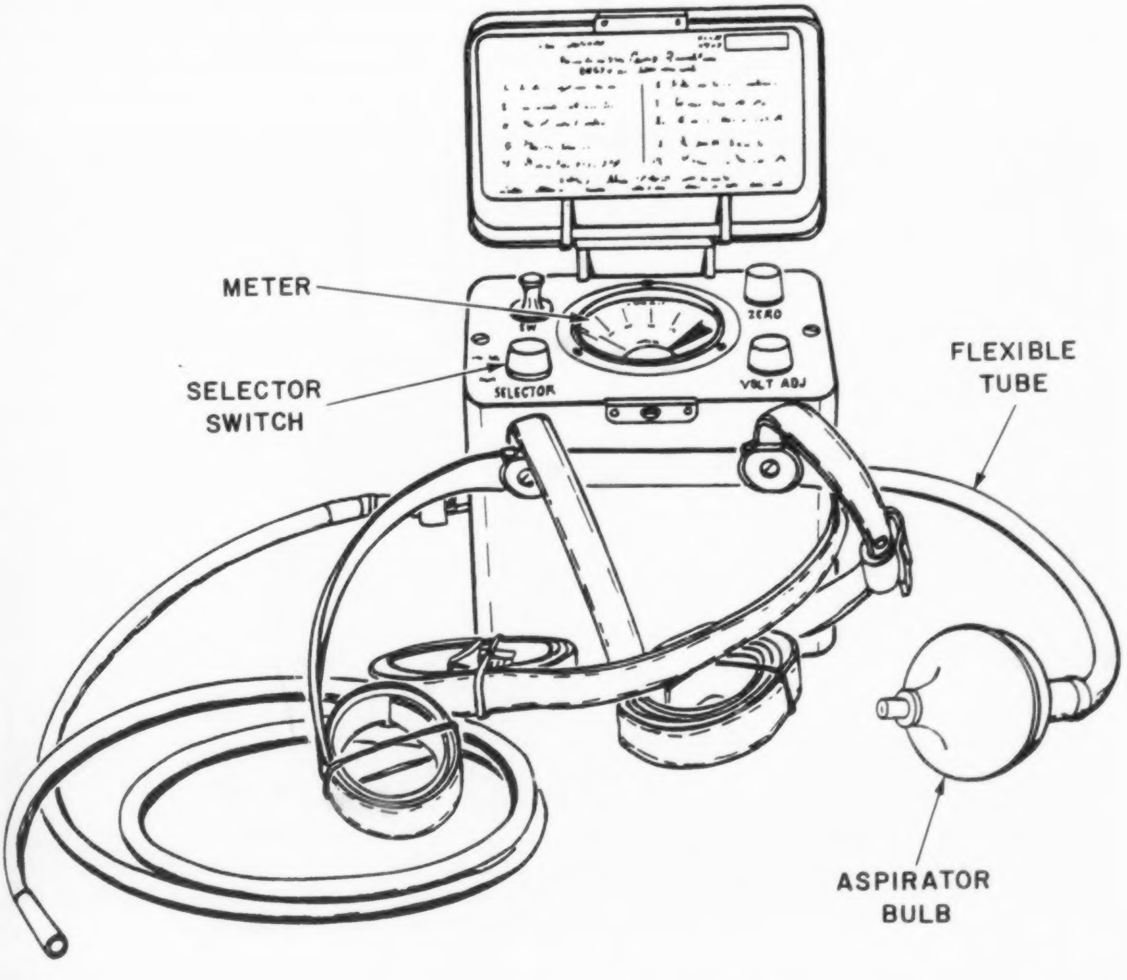

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Figure 6-36.—Combustible Gas Indicator Model 40 (MAF, UDMH vapor).

get the meter pointer to adjust to the CHECK position of the scale, replace the batteries. Eight D-cell batteries (BA-30) are required to operate the indicator.

8. Turn the SELECTOR switch to the 100% LEL position.

9. Adjust the meter pointer to ZERO. To make this adjustment, pull straight up on the ZERO adjustment knob. Turn the knob so that the meter pointer slightly overshoots ZERO. Then turn the knob slowly in the opposite direction until the meter pointer is on ZERO.

10. Turn the SELECTOR switch to the 10% LEL position.

11. Adjust the meter pointer to ZERO as described in step 9.

12. Turn the SELECTOR switch to 100% LEL.

13. Place the end of the sampling hose in the space being tested.

14. Squeeze the aspirator bulb 10 to 12 times for the indicator and 2 times for each 10 feet of sampling hose being used.

15. If the meter pointer stays below 10 on the lower scale, turn the SELECTOR switch to the 10% LEL position. Continue squeezing the aspirator bulb and take your reading from the top scale.

16. To secure the indicator, flush it and the hose out in fresh air. Then push down the SW knob and shut the cover.

TOXIC GAS INDICATORS

The Navy uses several types of toxic gas indicators. Some can only test for one type of gas. Others can test for several types of toxic gases, but only one type of gas at a time. The following discussion is based on the equipment that is most likely to be on your ship. When you use equipment on your ship, refer to the manufacturer's technical manual that is issued with the equipment.

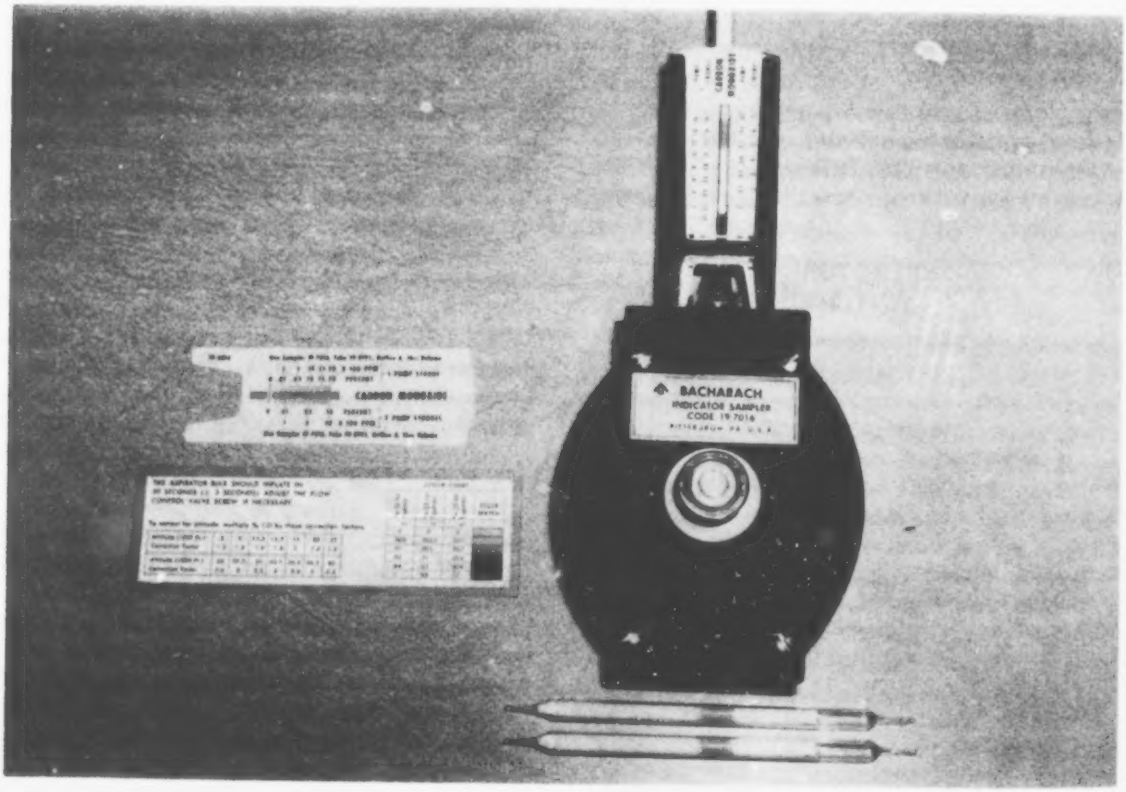

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Figure 6-37.—Bacharach universal gas sampler.

Bacharach Universal Gas Sampler

The Bacharach universal gas sampler (fig. 6-37) is used to test for carbon monoxide, hydrogen sulfide, carbon dioxide, chlorine, sulphur dioxide, and nitrogen dioxide. A different indicator tube and scale is used with the basic unit to check for each type of gas.

The following procedures should be used to test for carbon monoxide. However, the procedures discussed are the same for each of the gases.

1. Ensure that the orifice assembly is installed and the knurled clamp nut is finger tight. Ensure that the stop nut is in the correct position and the correct tube and scale are installed for the type of gas for which you are testing.

2. Unfold the scale frame and scale from the bottom of the sampler and swing it forward until it locks in place.

3. Slide the metal tip breaker on the bottom of the sampler back to open the tube breaker hole. Insert the indicator tube tip in the exposed hole and break off the tips to open both ends of the tube. Then push the slide forward to close the tip breaker hole.

4. Slide either end of the opened indicator tube through the wire loop scale. Continue inserting the tube until the tube tip is snugly inside the rubber tube connector of the sampler.

5. Depress the push button down as far as it will go and hold it there for several seconds. Release the push button quickly and allow it to return to its original position. A red line on the push button will be visible when the button is in the upright position.

6. When the red line is completely visible, wait 30 seconds before you examine the indicator tube for a brownish stain in the yellow-colored gel. If a stain appears, carbon monoxide is present in the area being tested.

7. Move the scale from right to left until only unstained gel appears in the short scale slot (A) to the left of the scale's zero bar (B) and only stained gel appears in the long scale slot. See figure 6-38. The stained gel includes all yellow gel that is visibly darkened by the carbon monoxide. The unstained gel is that portion of the yellow gel which is totally unaffected by the carbon monoxide. Read the scale at the point (C) where the stained gel and the white guard gel meet. To ensure maximum accuracy, rotate the indicator tube approximately 90 degrees to four positions. Then average your readings. The indicator tube in figure 6-38 has a reading of 0.015% carbon monoxide on the 3-pump scale.

8. If no stain is visible after 1 pump stroke, repeat steps 4 through 6 for a total of 2, 3, or 7 pump strokes for a greater sensitivity. When making the additional pump strokes, be sure to use the correct portion of the scale when you measure the length of the stained gel.

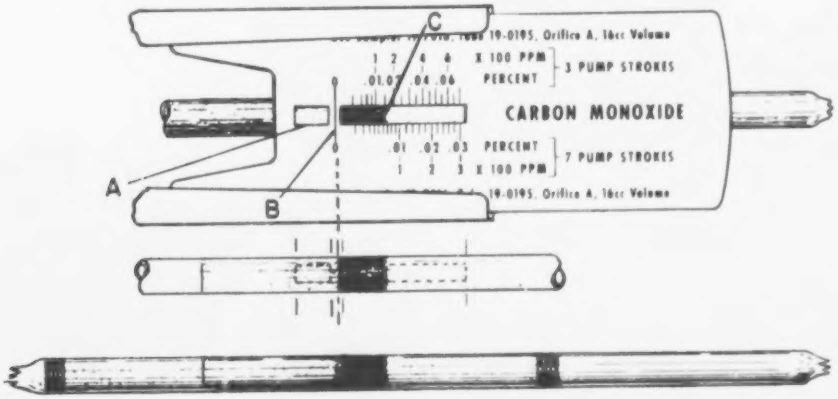

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Figure 6-38.—Bacharach universal gas sampler test for carbon monoxide.

Drager Multigas Detector

The Drager multigas detector (fig. 6-39) is used to test the atmosphere within a space for toxic gases such as carbon dioxide, carbon monoxide, nitrogen dioxide, and hydrogen sulfide. A separate detector bulb is used for each type of gas. For safety and accuracy, you should use only Drager detector tubes with Drager multigas detectors.

The unit consists of two main components—the bellows pump and the detector tube. It is simple to use. To operate the unit, use the following procedures:

1. Check the bellows pump for leaks before you conduct a test by inserting an unopened detector tube into the pump head and squeezing the bellows pump. If the bellows pump has not expanded completely after 30 minutes, the unit is safe to use.
2. Break off both tips of a detector tube. Use either the break-off eyelet on the unit or the break-off husk. The break-off husk is a separate accessory that is hand-held and comes with the unit.
3. Insert the detector tube tightly into the pump head. Ensure that the arrow on the tube points towards the pump.
4. Hold the bellows pump in your hand with the detector tube pointing upwards.
5. Squeeze the bellows until it is completely depressed. When the bellows is compressed, the air is forced out through the outlet valve instead of the detector tube.
6. Straighten your fingers so they are straight out along the side of the bellows. This creates the suction required to draw air into the detector tube. Allow the limit chain to become taut after each squeeze to complete the suction process.
7. Repeat the suction process as directed by the detector tube operating instructions. Each tube requires a different number of squeezes.
8. Evaluate your test results as described in the detector tube operating instructions.
9. Upon completion of the tests, flush out the bellows pump with fresh air. Do this by squeezing the bellows pump a few times without a detector tube inserted in the unit. This will help to prevent corrosion of the unit by vapors that are given off by various types of detector tubes.

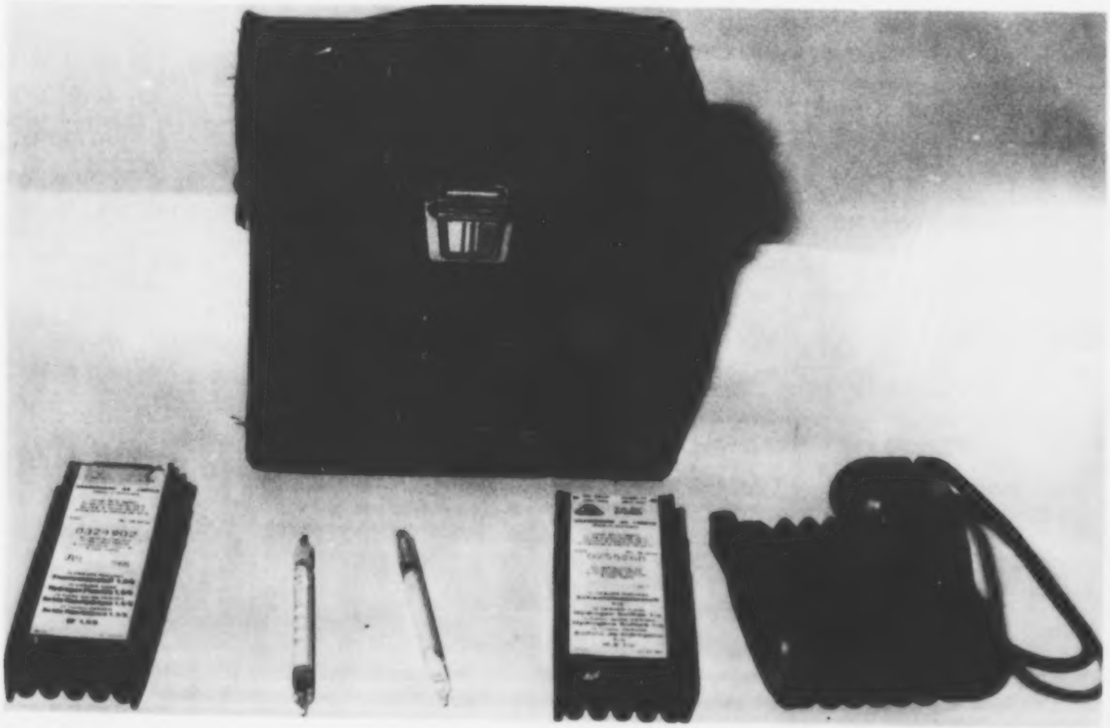

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Figure 6-39.—Drager multigas detector.

For additional information on atmospheric testing instruments and standard Navy gas-free testing procedures, refer to the *Naval Ships' Technical Manual*, chapter 074, volume 1.

FIGHTING THE FIRE

This section on fighting the fire covers getting to the fire, fighting the fire, preventing the spread of fire, procedures for followup to prevent reflash, and cleanup after the fire is out.

FORCIBLE-ENTRY TOOLS

To do an effective job when fire fighting, you must gain access to the fire. If the normal means of access are blocked, or locked, you will need to use forcible-entry tools to gain access into the area so that you can fight the fire.

The tools most frequently used for forcible entry are the sledge hammer, axe, crowbar, wrecking bar, claw tool, hacksaw, bolt cutter, and oxyacetylene cutting torch. It is important to know how to use these tools. Some of them, such as the sledge hammer, axe, crowbar, wrecking bar, and claw tool, require no special skills or knowledge. Therefore, we will discuss only the hacksaw, bolt cutters, and oxyacetylene cutting torch.

To use a HACKSAW properly, mount the blade with the teeth pointed away from the handle. Tighten the blade until it hums when plucked. Keep the blade tight or you may break it. Use long, steady, even strokes, about 40 or 50 strokes per minute. Do not try to work faster than this. Apply pressure on the forward stroke and then release the pressure on the return stroke. If the blade breaks during a cut, install another blade in the frame and start a new cut. A new blade has more set than an old one; if a new blade is used to finish a cut started by an old blade, the new blade is likely to bind and break.

BOLT CUTTERS may be used to cut mild steel stock up to one-half inch in diameter. Do not twist the bolt cutters when using them. If you do, you might break the jaws or blades. Emergencies may arise in which it will be necessary to cut electrical cables with a bolt cutter. NEVER attempt to cut electrical cables unless you are SURE that the cables have been de-energized.

The portable pack-type OXYACETYLENE CUTTING OUTFIT (fig. 6-40) may be used to cut holes in decks or bulkheads so that nozzles and applicators equipped with fog heads may be inserted to fight a fire. The outfit may also be used to cut away debris that would hinder fire fighters or rescue workers. These cutting outfits are to be used for emergencies only; never for routine cutting jobs.

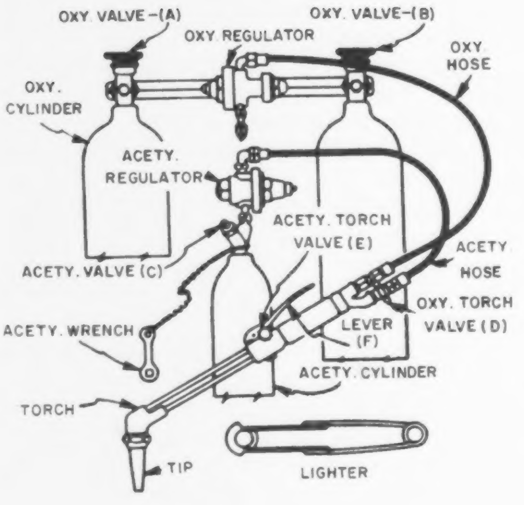

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Figure 6-40.—Portable pack-type oxyacetylene cutting outfit.

The cutting outfit shown in figure 6-40 consists of two oxygen cylinders, one acetylene cylinder, an oxygen cylinder manifold, preset regulators, hoses, torch, tip, gloves, igniter, wrenches, and goggles. The unit weighs 56 pounds. The oxygen cylinders have a capacity of 22 cubic feet. Each oxygen cylinder is charged to 1,800 psi. The acetylene cylinder has a capacity of 10 cubic feet and is charged to 250 psi. The preset regulators give a controlled ratio of 25 psi for oxygen and 5 psi for acetylene. Since the pressure cannot be regulated, gas welding cannot be performed with this outfit.

The hoses of the pack-type cutting outfit are 5 feet long. The acetylene hose is always red in color and always has left-hand threads. The oxygen hose is always green or black in color and always has right-hand threads. The torch is a medium cutting torch with a number 2 tip. The unit will cut ferrous metals up to 1 inch thick. When the unit is fully charged, it can be used for 30 minutes.

Before using the portable cutting unit, open both oxygen valves slowly to prevent damage to the regulator. Then open the valves all the way. Next, open the acetylene valve one-half of a turn, using the key provided. The unit is now ready to be strapped on your back.

To light the torch, open the acetylene needle valve a quarter turn and immediately ignite the fuel with the igniter. Do not delay, since this would allow a buildup of acetylene gas in the torch area. Next, open the oxygen needle valve a quarter turn and adjust the flame until you have a good neutral preheating flame. When the adjustment is correct, you should have a preheating flame that is a clear, blue-white cone about one-fourth of an inch long.

To cut metal with the oxyacetylene cutting torch, adjust the preheating flames to neutral. Hold the torch perpendicular to the work, with the inner cones of the preheating flames about one-sixteenth inch above the end of the line to be cut. Hold the torch in this position until the spot you are heating is a bright red. Introduce the cutting oxygen by depressing the oxygen lever slowly but steadily until it is fully depressed.

If you start the cut correctly, a shower of sparks will fall from the opposite side of the work, indicating that the cut is going all the way through. Move the cutting torch forward along the line just fast enough for the cut to continue to penetrate the work completely. If you have made the cut properly, you will get a clean, narrow cut which looks somewhat like one made by sawing. When cutting round bars or heavy sections, you can save time and gas if you raise a small burr with a chisel where the cut is to start. This small raised portion will heat quickly, and cutting can be started immediately.

If you start a cut from the center on some portion of metal other than the edge, use the following method: Preheat the spot on the surface where the cut is to start until it is bright red. Tilt the torch at an angle of about 45° from the perpendicular, in line with the direction of the cut. Press the cutting oxygen lever very slowly. As the torch begins to cut, start righting it to a perpendicular position to the surface of the plate. Continue to right the position of the torch gradually as it cuts until it is 90° to the surface of the place and is cutting all the way through. Move it forward along the line of cut as fast as you can get complete penetration. If you do not follow this procedure, you are likely to blow the slag back on the cutting tip. This will clog the orifices or otherwise damage the equipment.

When you have started a cut, move the torch slowly along the cutting mark or guide. As you move the torch along, watch the cut so you can tell how it is progressing. Make torch adjustments if necessary. You must move the torch along at the right speed. If you go too slowly, the preheating flame will melt the edges along the cut and may even weld them back together at the top surface. If you go too fast, the oxygen will not penetrate completely through the metal, and the cut will be incomplete. If that happens, you will have to release the cutting oxygen lever and start the entire operation over again at the beginning of the partially cut area.

To secure the portable pack-type cutting outfit, use the following procedures:

1. Close the acetylene valve on the torch.
2. Close the oxygen valve on the torch.
3. Close the acetylene cylinder valve.
4. Close the oxygen cylinder valves.
5. Open the torch acetylene valve to drain the acetylene line. Do this with the torch oxygen valve still closed. After the acetylene line has drained, close the torch acetylene valve immediately.
6. Open the torch oxygen valve to drain the oxygen line. Do this with the torch acetylene valve closed. After the oxygen line has drained, close the torch oxygen valve immediately.

If this procedure is followed, acetylene will not get into the oxygen line, nor will oxygen get into the acetylene line while you are lighting or securing the portable oxyacetylene cutting outfit. It is important to keep these gases from mixing; flashbacks result from mixed gases in either the oxygen line or the acetylene line. Flashbacks also result when the torch flame is not properly adjusted and maintained with the correct pressures, and when the tip orifices are not kept free of obstructions. Make sure that all valves are tightly closed before storing the unit. Check the oxygen pressure by removing the oxygen regulator and attaching a test gauge. If the oxygen pressure reading is below 500 psi, replace all three of the cylinders. This way you can maintain the 5-to-1 ratio of oxygen pressure to acetylene pressure.

When using the portable oxyacetylene cutting outfit, follow these safety precautions:

- Always wear protective gear, including goggles and gloves.

- Be sure that the space or area is safe for cutting before you begin. Always check to see what is on the other side of the deck or bulkhead before you start cutting.

- Station a fire watch.

- Never allow oil or grease to come in contact with oxygen cylinders, valves, regulators, hoses, or fittings. Do not handle any oxygen equipment with oily hands or oily gloves. Grease or oil in the presence of oxygen under pressure is violently explosive.

- Use and store the cylinders in an upright position. This is particularly important for acetylene cylinders. It prevents acetone from being discharged with the acetylene when the cylinder is in use.

- Never use an acetylene working pressure in excess of 15 psi. There is danger of an explosion above this pressure.

- Take the unit to a clear area topside if leakage is suspected. With your back to the wind, expend the acetylene gas slowly. Use only a mild soap and water solution to test for leakage.

- Be sure that all cylinder valves are tightly closed when the unit is not in use.

BASIC FIRE-FIGHTING PROCEDURES

Since no two fires are exactly alike, the procedures for fighting fires must vary to fit the circumstances. In fact, flexibility is an important aspect of fire fighting. Often it is necessary to make split-second changes in techniques or methods of extinguishing a fire, as the fire can change its pattern.

Basically, there are certain things that must be determined before you can attack any fire. These include finding answers to the following questions:

- Where is the fire?

- What is burning? What class of fire is it?

- What is the extent of the fire? Does it involve more than one type of combustible material?

- What other combustible materials are located nearby? What special problems will exist if they catch fire?

Acting on information as to the location and nature of the fire, the scene leader makes a quick survey to determine what methods and equipment should be used to extinguish the fire. The scene leader must also make decisions concerning the need for additional men and equipment to combat the fire.

Once the location, nature, and extent of the fire have been determined, a fire area is established in which all safety precautions must be observed and from which all combustible materials must be removed. Within the boundaries of the fire area, doors, hatches, manholes, ventilation ducts, and other openings are closed where practicable and necessary. The scene leader also directs the de-energizing of electrical circuits.

The selection of agents and equipment to extinguish a fire is based upon a number of factors. These include the availability of equipment and the effects of the various agents. The various fire-fighting agents perform as follows: Water wets, penetrates, and cools; water fog wets, cools, and shields; aqueous film forming foam (AFFF) smothers permanently; CO_2 smothers temporarily; while two agents, dry chemical PKP and Halon 1301, interfere with combustion to give the effect of temporary smothering.

The agents and equipment used to extinguish various kinds of fires are listed, in the preferred order of use, in the following paragraphs:

- CLASS A fires in woodwork, bedding, clothing, and similar kinds of combustibles: (1) fixed water sprinkling, (2) high-velocity fog, (3) solid water stream, (4) AFFF, (5) PKP, (6) CO_2 extinguishers, and (7) Halon 1301.

- CLASS A fires in explosives or propellants: (1) magazine sprinkling, (2) AFFF, and (3) solid water stream or high-velocity fog.

- CLASS B fires in paints, spirits, and flammable liquid stores: (1) fixed CO_2 installation, (2) AFFF, (3) installed sprinkling system, (4) PKP, (5) high-velocity fog, (6) portable CO_2 extinguishers, and (7) Halon 1301.

- CLASS B fires in gasoline: (1) installed (fixed flooding) CO_2 systems, (2) TAU, (3) AFFF, (4) PKP, (5) water sprinkling system, and (6) Halon 1301.

- CLASS B fires in fuel oil, JP-5, diesel oil, and kerosene: (1) installed CO_2 systems (fixed flooding), (2) AFFF, (3) PKP, (4) water sprinkling system, (5) high-velocity fog, and (6) Halon 1301.

- CLASS C fires in electrical and electronic equipment (after de-energizing affected circuits): (1) portable CO_2 extinguishers or CO_2 hose-and-reel systems, (2) Halon 1301, (3) PKP, and (4) high-velocity fog (no closer then 4 feet).

- CLASS D fires in combustible metals: (1) jettison into the sea, if possible, and (2) high-velocity fog (in quantity).

Special hazards may develop when Mark 24 and Mark 45 flares are carried aboard ship. These flares consist of powdered magnesium and other chemicals. Although flare fires are extremely hard to put out, they can be extinguished by the techniques described here.

After a Mark 24 flare has been accidentally activated, you have only 10 to 30 seconds to take action before the flare ignites. If the accidental activation is discovered immediately, it is usually possible to knock the ignition assembly off or to drag the flare by its parachute to get it away from other flares and aircraft. If the flare is to be thrown overboard, try to cut the shroud lines so the flare will not be fouled or blown back onto the deck.

In the case of the Mark 45 flare, a pull on the lanyard results in ejection of the candle and IMMEDIATELY starts ignition. To dispose of this flare, pick it up bodily, with ends pointing away from you, and remove it to a safe spot. Do not attempt to jettison it with the parachute attached.

If it is impossible to get rid of an activated flare, fight the fire with a 1 1/2-inch hose and the all-purpose nozzle with a 4-foot or 10-foot applicator attached. Use antiflash gloves and number 6 shade welding goggles. This protection is very important, since flares burn at 2 million candlepower.

Approach the fire from the windward side, if possible. Insert the applicator fog head into the burning end of the flare and, with a slight oscillating motion, wash the burning face from the nonburning candle grain. DO NOT use a solid stream of water.

If one flare or several have ignited in a pile of flares, you will have about 1 minute before the other flares ignite. Separate the flares so that the burning ones can be extinguished individually. Fire axes, rakes, forcible-entry tools, or even the applicator itself can be used to separate the flares.

Rapid action is vitally important in fighting a flare fire, particularly below decks or in confined spaces. Water applied to a magnesium fire liberates hydrogen gas, which is violently explosive in certain concentrations. The faster the flare fire can be extinguished, the less danger there is of a hydrogen gas explosion.

PREVENTING THE SPREAD OF FIRE

Preventing the spread of a fire is a vital part of shipboard fire fighting. It is a job that must be undertaken simultaneously with the job of fire extinguishment. A fire that is properly contained so that it cannot spread is well on the way to being controlled.

Various techniques may be used to keep a fire from spreading. Sometimes it is possible to set up a fire barrier of fireproof materials. In many situations you will have to establish fire barriers by keeping combustible materials in the area cooled with water. When particularly dangerous combustible materials such as gasoline or explosives are located nearby, you should remove them from the fire area. The bulkheads, decks, and overheads adjacent to a fire should be cooled with water to prevent the spread of fire by conduction or radiation. This cooling will also help to keep the structures from being weakened and distorted by the heat of the fire. Sometimes it may be necessary to fill adjacent compartments with CO_2 to keep the fire from spreading to combustibles in those compartments.

One of the most important phases of preventing the spread of fire has to do with the correct operation and maintenance of the ship's ventilation systems. The question of whether or not to secure the ventilation system during fire-fighting operations depends upon the particular circumstances existing at the time. It is important to remember, however, that any ventilation system can provide a means by which a fire can rapidly spread from one compartment to another, or from one area of the ship to another.

The danger of a fire spreading through the ventilation system is particularly great if there is dirt or dust in the duct work, on the screens, or in any other part of the ventilation system. Therefore, it is very important to make sure that the ventilation systems are inspected regularly and cleaned as often as necessary. A regular ventilation system cleaning schedule should be established and followed aboard ship. Vent ducts, heaters, screens, grease filters, flame arrestors, laundry filters, and all other parts of the ventilation systems must be kept clean. Vacuum cleaners, brushes, and low-pressure compressed air may be used to loosen and remove dirt from ducts, vents, heaters, and screens. Flame arrestors, grease filters, and laundry filters may be washed with a dishwashing compound and then rinsed with warm water.

OVERHAULING THE FIRE

After a fire has been extinguished, it must be overhauled. This is done to make sure that it will not start burning again (reflash). The general procedures for overhauling a fire include breaking up the combustible materials with a fire axe or a fire rake and cooling the fire area with water or fog. Since many fires can flare up again after they appear to be out, it is necessary to set a reflash watch after a fire has been extinguished.

DESMOKING

After a fire has been definitely extinguished and overhauled, it is usually necessary to desmoke the compartments involved. This is done by natural or forced ventilation. However, before any ventilation is undertaken, you must observe the following precautions:

1. Be SURE that the fire has actually been extinguished, and that the atmosphere tests for oxygen and explosive gases are completed and acceptable results obtained.
2. Investigate the ventilation systems to the affected areas to be sure they are free of burning or smoldering materials.
3. Have fire parties and equipment standing by the blower and controller of the ventilation systems.
4. Obtain permission from the engineer officer to open ventilation system closures and to start the blowers required to desmoke the compartments involved.

You need to decide whether to use exhaust systems or supply systems for desmoking. If supply systems are used to ventilate interior spaces, smoke and fumes are usually forced into adjacent spaces. Spaces directly open to the weather can be cleared by supply systems without any particular problem.

Portable electric or pneumatic (air) ventilating blowers can be used for desmoking, although they are not as efficient or convenient as installed ventilating systems. However, when explosive vapors or fumes are present, it may be dangerous to use installed ventilation systems. Under these circumstances, portable ventilating blowers are usually used. The following portable ventilating blowers are available for use in the Navy.

- The Red Devil blower is an axial-flow type blower and is fitted with a noncollapsible hose that is 8 inches in diameter. The rated capacity of this blower is 500 cubic feet per minute with about 200 feet of 8-inch hose attached. This blower is driven by an explosion-proof electric motor; that is, the motor is explosion proof when it leaves the factory. It may or may not be explosion proof after is has been overhauled or mishandled during previous usage. Therefore, if these motors have been overhauled, mishandled, or suspected of not being explosion proof, they should NOT be used where the presence of explosive vapors is suspected.

- The A3/4T air-turbine driven centrifugal type of blower is fitted with an 8-inch noncollapsible hose. This blower, which was developed to handle air that contains explosive vapors, is driven by compressed air supplied at a pressure not to exceed 80 psi. This blower has a rated capacity of 750 cubic feet per minute with about 100 feet of 8-inch hose attached.

DEWATERING

One of the special hazards of fire fighting aboard ship is that it is possible to sink the ship while putting out the fire. A standard Navy 2 1/2-inch nozzle operating at 100 psi nozzle pressure can discharge almost a ton of water per minute. It is of vital importance to remember that all water pumped into the ship must be drained or pumped out again; this must be done rapidly enough to prevent a critical impairment of the ship's stability. Remember, flooding water has the same effect on stability, whether it enters the ship by accident or by intent. The effect of water used for fire fighting can be just as disastrous as the effects of water entering through holes in the hull. This is especially true when you are fighting fires in spaces that are high in the ship. In either case, flooding must be controlled promptly and efficiently.

Dewatering should be done according to the ship's stability and loading diagram (DC diagram No. 1). Loose water (that is, water with a free surface) and water located high in the ship should be removed first. Compartments that are solidly flooded and are low in the ship are generally dewatered last. An exception is when the flooding is sufficiently off-center to cause a serious list. Compartments must always be dewatered in a sequence that will contribute to the overall stability of the ship. For example, a ship could be capsized if solidly flooded compartments low in the ship were dewatered while water still remained in partially flooded compartments high in the ship.

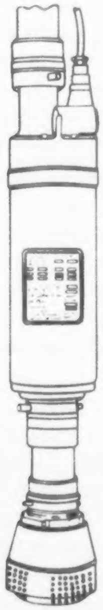
Facilities for dewatering compartments consist of fixed drainage systems and portable equipment such as electric submersible pumps and eductors. The P-250 pump, described in chapter 5 of this training manual, may also be used for dewatering.

Submersible Pumps

The portable submersible pump (fig. 6-41) used aboard naval ships is a centrifugal pump driven by a water-jacketed constant speed ac or dc electric motor. The latest design of submersible pump is rated to deliver 140 gallons per minute against a maximum head of 70 feet. When the head is reduced to 50 feet, the output rises to 180 gallons per minute. Basket strainers are always used with submersible pumps when flood water is being pumped.

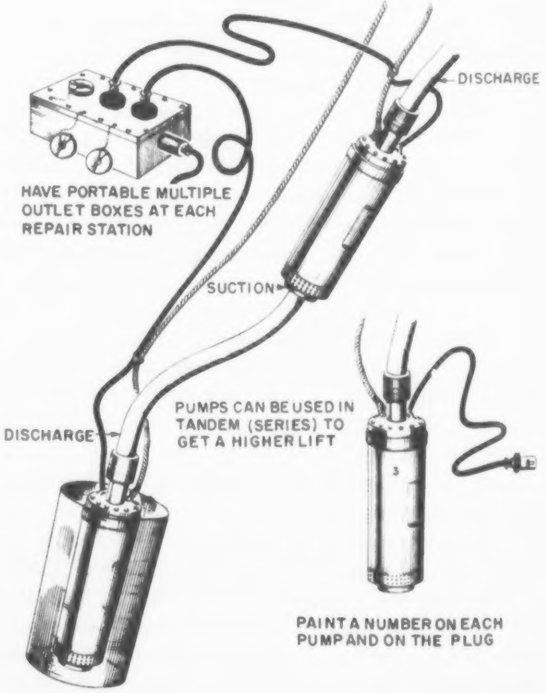
To dewater a compartment with a submersible pump, lower the pump into the water using the attached nylon handling line and lead the 2 1/2-inch discharge hose to the nearest point of discharge. The amount of flooding water taken from a flooded space increases as the discharge head decreases. Therefore, dewatering is accomplished most efficiently if the water is discharged at the lowest practicable point and if the discharge hose is short and free from kinks. When it is necessary to dewater against a high discharge head, you can use two submersible pumps in tandem (series) as shown in figure 6-42. The pump at the lower level lifts water to the suction side of the pump at the higher level. A multiple outlet box is provided for making the necessary electrical connections.

When using a submersible pump, always lower it and raise it by the nylon handling line and NOT by the electric cable. Handling the pump by the electric cable could break the watertight seal where the cable enters the housing. The handling line is secured to the pump housing through an eye installed for that purpose. It may be married to the power cable (tied together),



8.505

Figure 6-41.—Ac portable electric submersible pump.


DISCHARGE
HAVE PORTABLE MULTIPLE OUTLET BOXES AT EACH REPAIR STATION
SUCTION
PUMPS CAN BE USED IN TANDEM (SERIES) TO GET A HIGHER LIFT
DISCHARGE
3
PAINT A NUMBER ON EACH PUMP AND ON THE PLUG

11.359

Figure 6-42.—Tandem connections for submersible pumps.

provided considerable slack is left in the cable at the pump end.

Submersible pumps are not designed to pump gasoline or heavy oil. Since the pumped liquid circulates around the motor as a coolant, gasoline can leak into the motor and cause an explosion. If you use a submersible pump to pump heavy oil, the motor will burn out because the viscous liquid will impose a heavy load on the motor. Also, a heavy, viscous liquid will not dissipate heat rapidly enough to keep the motor cool.

Use the following questions as a checklist to make sure that submersible pumps are in good operating condition and ready to be used:

- Is the handling line properly secured to the eye of the pump?

- Is the motor casing watertight? This point should be checked by testing the pump with air pressure. Do not wait until the pump is needed for emergency operations; check it out ahead of time. (Have an Electrician's Mate assist you in this check.)

- Are the foot valves equipped with washers and gaskets?

- Is a strainer mounted on the pump? A basket strainer can easily be made from number 3 mesh screen wire.

- Is a spare basket strainer kept at each repair party locker?

- Is the discharge fitting cap in place?

- Is the cable stuffing tube properly packed? (Have an Electrician's Mate check the cable stuffing tube.)

- Is a portable multiple outlet box provided at each repair party locker?

- Is a 75-foot jumper cable available at each repair party locker for use in case of local power failure?

- Are the necessary spanner wrenches provided for removing and replacing strainers and for making hose connections?

Observe the following safety precautions when the pump is being placed in operation and when it is actually in use:

- Keep the handling line, the electric cable, and the discharge hose clear so that the pump can be removed quickly.

- Keep the hose free of kinks.

- Always use a basket strainer.

- Keep the suction end of the pump or the end of the suction hose in water while the pump is operating.

- Keep the strainer clean and free of debris.

- NEVER use an electric submersible pump or any other apparatus that might produce a spark if you are pumping where explosive vapors may be present.

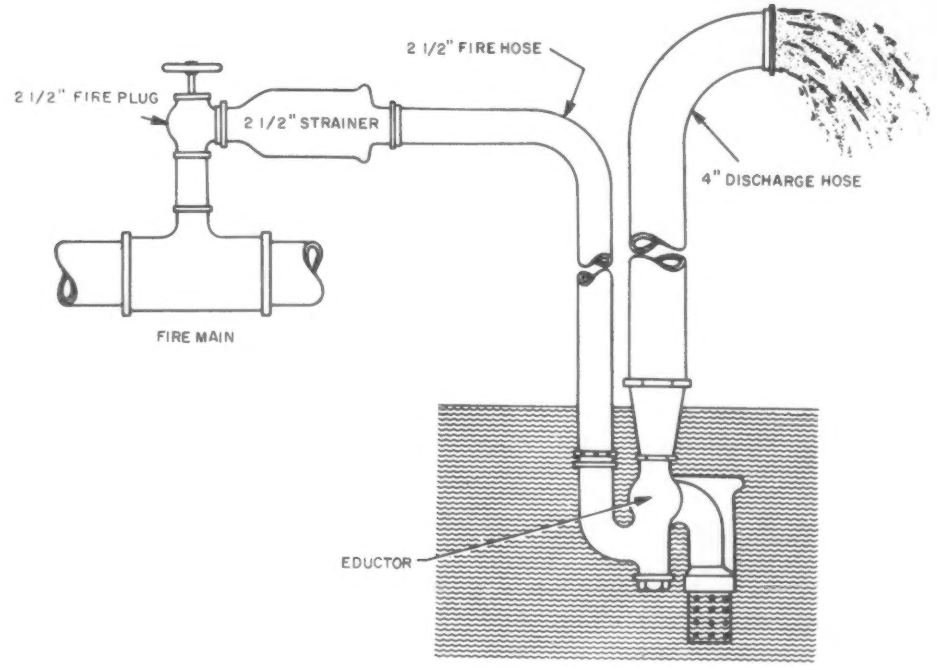
- Ensure that the discharge flow is unrestricted.

- A qualified electrician is the only person of an emergency repair party authorized to energize or de-energize an electric submersible pump.

Eductors

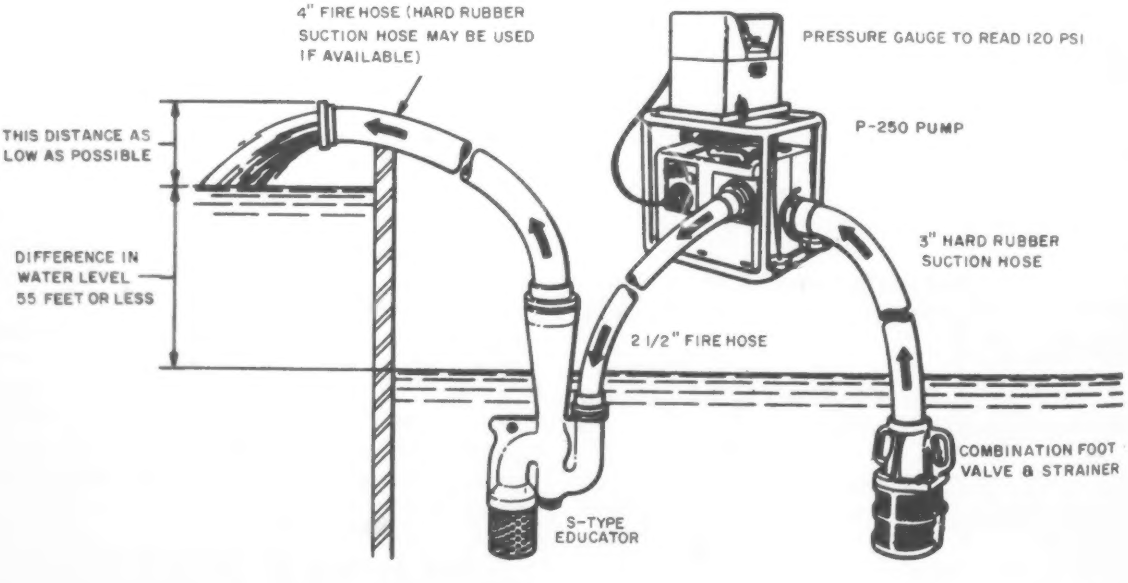
Eductors are jet-type pumps that contain no moving parts. An eductor moves liquid from one place to another by entraining the pumped liquid in a rapidly flowing stream of water (venturi effect). The eductor can perform low-head dewatering operations at a greater rate of discharge than can be obtained by straight pumping with available emergency pumps. Educators are used to pump liquids that cannot be pumped by other portable pumps. Also, liquids that contain fairly small particles of foreign matter can be pumped by using an eductor.

Since the operating medium of an eductor is water under pressure, portable eductors can be actuated by the ship's firemain pressure. This is accomplished by connecting a 2 1/2-inch


2 1/2" FIRE HOSE
2 1/2" FIRE PLUG
2 1/2" STRAINER
4" DISCHARGE HOSE
FIRE MAIN
EDUCTOR

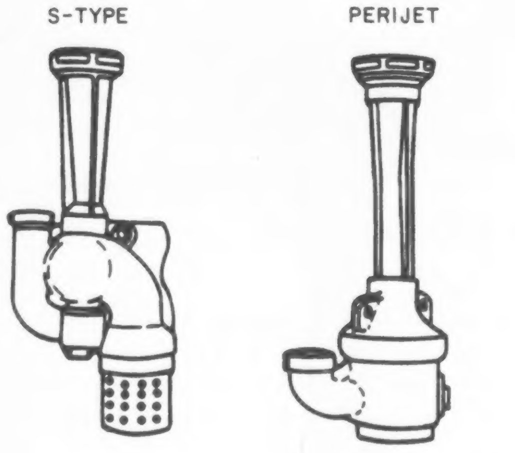
3.163

Figure 6-43.—Eductor connected to firemain.


4" FIRE HOSE (HARD RUBBER SUCTION HOSE MAY BE USED IF AVAILABLE)
PRESSURE GAUGE TO READ 120 PSI
THIS DISTANCE AS LOW AS POSSIBLE
P-250 PUMP
DIFFERENCE IN WATER LEVEL 55 FEET OR LESS
3" HARD RUBBER SUCTION HOSE
2 1/2" FIRE HOSE
COMBINATION FOOT VALVE & STRAINER
S-TYPE EDUCATOR

3.161.4

Figure 6-44.—P-250 pump and eductor rigged for dewatering a flooded compartment.



8.506

Figure 6-45.—Portable eductors.

hose to the nearest fireplug and to the eductor (fig. 6-43).

You must remember that not all of the eductor discharge comes from the compartment being dewatered. For example, when a 4-inch portable eductor is activated by water from the firemain system at 100 psi, 182 gallons per minute of water is required for the operation of the eductor. Working against a head of 40 feet, the eductor will discharge a TOTAL of 333 gallons per minute. This amount includes the 182 gallons per minute that is being pumped into the compartment to activate the eductor. Therefore, the NET discharge of the eductor is 333 less 182 gallons per minute, or 151 gallons per minute. The compartment's dewatering rate is only 151 gallons per minute.

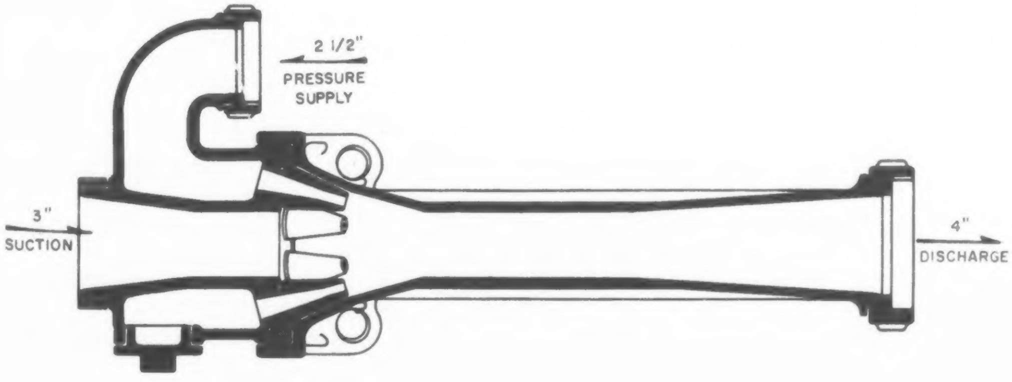
Eductors can be permanently installed and activated by opening a firemain valve, or they can be rigged as required to dewater a compartment or space. They are often used with the P-250 pump to dewater compartments. Figure 6-44 shows one arrangement that could be used. In this arrangement, both the P-250 pump and the eductor are removing water from the flooded compartment.

When using an eductor for dewatering, remember that the pressure of the water supplied for the operation of the eductor must always be substantially higher than the pressure against which the eductor is required to discharge. If this requirement is not met, the water supplied for operation of the eductor will merely back up through the eductor and assist in the flooding of the compartment. A simple rule to follow is that the pressure of the water supplied for operation of the eductor must be at least three times the static head pressure against which the eductor must discharge. Multiply the discharge head in feet by 0.433, which is the weight of a column of water 1 inch square and 1 foot high. Then multiply the answer by 3 to obtain the pressure required. For example, suppose that the eductor must discharge against a static head of 50 feet. When you multiply 50 by 0.433, you have 21.65 psi. Then multiply 21.65 psi by 3 to get 65.95, or approximately 65 psi. This is the MINIMUM firemain pressure required when the eductor must discharge against a static head of 50 feet.

Two types of eductors (fig. 6-45) are available for shipboard use. One is known as the S-type or single-jet eductor. The other is known as the perijet eductor. Both types of eductors have a 2 1/2-inch inlet and a 4-inch discharge.

The S-type or single-jet eductor is used for dewatering and also for supplying the P-250 pump.

The perijet eductor (fig. 6-46) is actuated by six jets around the periphery of the vacuum



3.161.6

Figure 6-46.—Cross-sectional view of perijet eductor.

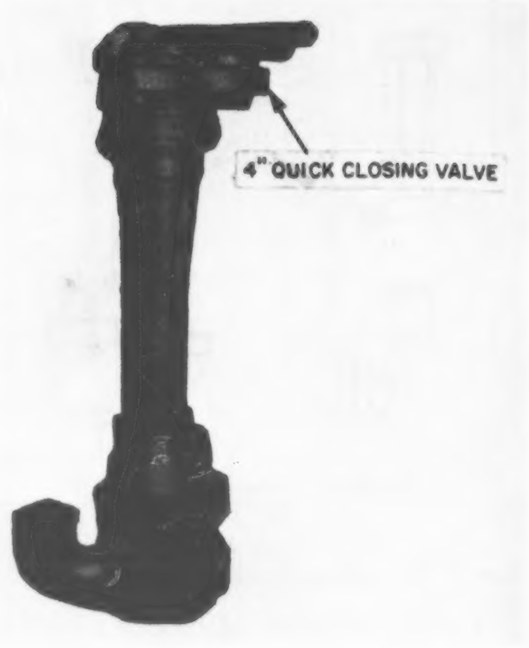
chamber. There is a straight bore of approximately 2 1/2 inches through the eductor base into the discharge section. The 2 1/2-inch opening allows debris up to 2 1/2 inches in diameter to pass through the eductor. A 4-inch quick-closing valve (fig. 6-47) is provided at the discharge side to clear the eductor of debris by forcing actuating water back through the intake. Since the perijet has no foot valve, low firemain pressure can result in merely adding water to the compartment instead of removing water from it. The absence of the foot valve also makes the perijet unsuitable for use as a source of supply to the P-250 pump. However, this can be overcome by attaching a P-250 combination foot valve and strainer to the suction side of the perijet with a special 3- to 4-inch adapter. The 3- to 4-inch adapter is required as repair locker equipment. Overall, the perijet eductor is about 7% more efficient than the single-jet eductor.

The following points should be kept in mind when you use an eductor:

- Be sure that the actuating pressure is AT LEAST three times the static head pressure against which the eductor must discharge.
- Keep the supply and the discharge hoses free of kinks.
- If it is necessary to use a suction hose with a perijet eductor, ensure that you use a hard rubber hose.
- Charge the eductor only when it is fully submerged.
- Keep the eductor fully submerged while operating it.

SUMMARY

In this chapter, you were introduced to various protective equipment and atmosphere testing devices. The basic fire-fighting procedures and the equipment involved were also discussed. As you participate as an active member of the duty in-port fire party and as a member of a repair party at sea, you will become more familiar with the equipment, systems, and procedures used to combat fire and flooding. Refer to the *Repair Party Manual*, the NWP 62-1, the *Naval Ships' Technical Manual*, chapter 074, volume 3, the *Naval Ships' Technical Manual*, chapter 079, volume 2, and the *Naval Ships' Technical Manual*, chapter 9930, for more information on damage control and fire-fighting equipment and procedures.



3.161.5

Figure 6-47.—External view of periject eductor.

CHAPTER 7

BATTLE DAMAGE REPAIR

To repair battle damage, you must have an extensive knowledge of the available damage control equipment and materials. You must know how to repair holes in the hull and use shoring. These topics are discussed in this chapter.

DAMAGE CONTROL EQUIPMENT AND MATERIALS

The equipment and materials required to make repairs to battle damage vary according to the nature of the damage. Since several types of damage can occur aboard ship, you must know how to use a wide variety of equipment and materials. The *Repair Party Manual* has several repair locker inventory lists for various types of ships. A typical repair locker will usually contain some or most of the following equipment, depending upon the ship's allowance:

- Oxygen breathing apparatus and six canisters for each OBA on the allowance
- Protective gloves (hot work, nonasbestos)
- Proximity suits
- Tending lines
- Miner's lights
- Flashlights
- Sealed-beam lights
- Battle lanterns
- Extension lights
- Sounding rods/sounding tapes
- Helmets
- Life jackets
- Hand tools
- Electrical tools
- Chain hoist and straps
- Blocks and tackle
- Screw and hydraulic jacks
- Manila line
- Forcible entry tools
- X40J cable and jack boxes
- Oxygen indicator
- Combustible gas indicator (explosimeter)
- Toxic gas detector
- Respirators
- Air-line hose masks
- Emergency-cutting outfit
- Electrical kits
- Rubber boots
- Rubber gloves
- Spare electrical cable
- Steel wedges
- Hose and pipe flanges
- Hose and pipe adaptors

- Shoring kit and shoring batten
- Plugging kit
- Pipe-patching kit (soft patches)
- Blower sleeves
- Prefabricated patches (wood and steel)
- Sound-powered phones
- Basket strainer
- Submersible pump
- Gas masks
- CBR defense protective clothing
- CBR defense detection equipment and markers
- Decontamination equipment
- Fire rakes and ladders
- Foam nozzles and extra fire hose
- In-line foam inductor

On ships that have subgroups, some of this equipment is stowed in the unit lockers. Additional damage control equipment is dispersed throughout the ship in designated areas. This equipment includes the following:

- Portable gasoline-driven fire pumps (P-250 or P-250 Mod 1) and hoses
- Fire hose
- Nozzles
- Applicators
- FP-180 water motor proportioner
- Spare AFFF cans
- CO_2 extinguishers
- Dry-chemical extinguishers
- Portable blowers
- Shallow-water diving gear
- Submersible pumps
- Eductors
- Shoring kit
- Shoring materials
- Plate patches
- Battle lanterns
- Casualty power cables

RELIABILITY OF DAMAGE CONTROL EQUIPMENT

The damage control organization cannot function without an adequate supply of damage control equipment. As a Damage Controlman, you will help to ensure that all damage control equipment is available and in good condition.

Frequent inspections are required in accordance with PMS guidelines. Those inspections ensure that all damage control equipment, tools, and materials on your ship's allowance list are actually on board. Compare the ship's allowance list with an accurate and up-to-date inventory list of onboard damage control equipment.

Check to see that all damage control equipment is stowed or installed in its designated location and that it is readily accessible. Emergencies can be handled much more effectively if the equipment is available and if you do not have to waste time looking for it.

The equipment assigned to each repair locker should be identified in such a way that each of the items can be returned to that repair locker after they have been used. A simple color code marking system can be used. All tools and equipment that belong to a certain repair locker should be marked with a striped band or a spot of that repair locker's identifying color.

Damage control equipment should NEVER be used for any purpose other than damage control. Damage control equipment is located throughout the ship, and some people are tempted to use it just because it is handy. This must NOT be allowed. All hands must realize that their lives may literally depend upon the ready availability and condition of damage control equipment in an emergency.

DAMAGE CONTROL KITS

At each repair locker a number of repair kits are made up and stowed in canvas bags. These kits are kept ready to be taken to the scene of damage. The kits should be constructed and packaged so that they will fit through the smallest watertight scuttle on your ship. These kits are commonly alled plugging kits, pipe-patching kits, and shoring kits.

Each damage control kit should have a list of contents attached to the carrying strap. The list makes it relatively simple to inventory the contents of the kit. All damage control kits and repair locker equipment must be inventoried in accordance with PMS requirements and after each use. Any equipment or material found missing during the inventory should be replaced as soon as possible. The ship's *Repair Party Manual* and *Surface Ship Damage Control*, NWP 62-1, list the equipment that is required in the ship's repair lockers. Your ship's coordinated shipboard allowance list (COSAL) shows the amount of each item that is allowed for the ship. Extra plugging and pipe-patching kits are made up for the engineering spaces. These extra kits are inventoried and maintained by the personnel assigned to the engineering spaces. Each damage control kit should be identified by a stencil on the outside of the bag.

RIGGING GEAR

Repair lockers have various kinds of rigging gear, such as chain falls, screw or hydraulic jacks, wire hawsers, block and tackle, and manila line. This gear is useful to clear away wreckage, restore equipment to its original position, and shoring. To a limited extent, you can use rigging gear to hold equipment in position. However, do not rely upon it to do the work of shores. You can use a jack to push heavy weights back to their proper positions. You may want to use chain falls and block and tackle to pull weights back into position or to hold equipment in place while shoring. Whenever equipment is being hoisted, be sure the rigging gear is secured to a stout pad eye, beam, or strongback. If the weight is loose and free to move, check the motion with steadying lines.

PATCHING MATERIALS

A number of materials are available to plug and patch holes and to cover and secure patches. Some of the materials commonly used for these purposes are mentioned here.

Plugging and patching materials include wooden plugs and wedges, wooden shoring, prefabricated wooden box patches in various sizes, rags, pillows, mattresses, blankets, kapok life jackets, metal plate, folding metal plate patches, flexible sheet metal patches, prefabricated steel box patches, bucket patches, and welded steel patches.

Securing materials include assorted hook bolts, manila line, wire rope, chain, machine bolts, angle clips for welding, and shoring.

Backup materials include mess tables, metal joiner doors, buckets, plywood or lumber, sheet metal, and metal plate.

Gasket materials include sheet and strip rubber, leather, canvas, rags, oakum, and paint.

HOLES IN THE HULL

Any rupture, break, or hole in the ship's outer hull plating, particularly below the waterline, can allow seawater to enter the ship. If flooding continues uncontrolled, the ship will sink. When the underwater hull is pierced, there are only two possible courses of action. The first, obviously, is to plug the holes or openings. The second is to establish and maintain flooding boundaries within the ship to prevent further progress of the flooding. Dewatering can be effective only after these two measures have been taken.

There is one very important thing to remember about flooding: a ship can sink just as easily from a series of small and insignificant looking holes as it can from one large and more dramatic looking hole. The natural tendency is to attack the obvious damage first and to overlook the smaller holes in the hull and in interior bulkheads. You may waste hours trying to patch large holes in already flooded compartments. Meanwhile, you disregard the smaller holes through which progressive flooding is taking place. In many cases, it would be better to concentrate on the smaller holes. As a rule, the really large holes in the underwater hull cannot be repaired until the ship is dry-docked.

All holes in the hull, large or small, should be plugged completely as soon as possible. As an interim measure, all holes should be partially plugged if they cannot be completely plugged. Even a partial plug can substantially reduce the amount of water entering the ship. This will substantially reduce the danger of sinking.

Holes in the hull that are at or just above the waterline should be given immediate attention. Holes in this location may not appear to be dangerous but they are. As the ship rolls or loses buoyancy, the holes become submerged and allow water to enter at a level that is dangerously high above the ship's center of gravity. These holes must be plugged at once. Give the holes at the waterline or on the low side priority (if the ship is listing), and then plug the higher holes.

The same methods and materials used to repair holes above the waterline are also used, for the most part, in the repair of underwater holes. The repair of underwater holes tends to be more difficult. Therefore, any Damage Controlman who can repair underwater damage must certainly be able to repair similar damage above the waterline. For this reason, most of the discussion in this chapter will deal with the repair of underwater damage.

FACTORS AFFECTING UNDERWATER REPAIRS

The two main factors that make it difficult to repair underwater holes are the pressure exerted by the water and the relative inaccessibility of the damage. The difficulties caused by water pressure are often exaggerated. Actually, a hole 7 feet below the waterline is only subjected to a water pressure of about 3 pounds per square inch.

Figure 7-1 shows the flooding effect of unplugged holes and of the same holes after inserting simple plugs. The volumes of flooding water are given in gallons per minute. The number of electric submersible pumps required to handle the flooding is also shown. It should be obvious that prompt plugging of holes is desirable. It can save the ship, it releases pumps for use elsewhere, and it saves wear and tear on the pumps that are in use. Note that the pump capacities used are considerably under the rated capacity, usually 180 gpm. However, if the pump strainers get clogged with debris, the actual capacities may be much less than the rated capacity.

The greatest difficulty in repairing underwater damage is usually the inaccessibility of the damage. If an inboard compartment is flooded, other compartments will flood if you open doors or hatches to get to the actual area of damage. In such a case, it is usually necessary to send a crew member wearing a shallow-water diving outfit down into the compartment. The repair work may be hampered by tangled wreckage in the water, the absence of light, and the difficulties of trying to keep buoyant repair materials submerged.

PLUGGING AND PATCHING HOLES

The procedures discussed here for plugging and patching holes are intended for emergency use. They are temporary repairs that can be done to keep the ship afloat while it is in action. In most cases, they do not call for elaborate tools or equipment. They involve principles that can be applied when using wooden plugs, prefabricated patches, or other readily available materials.

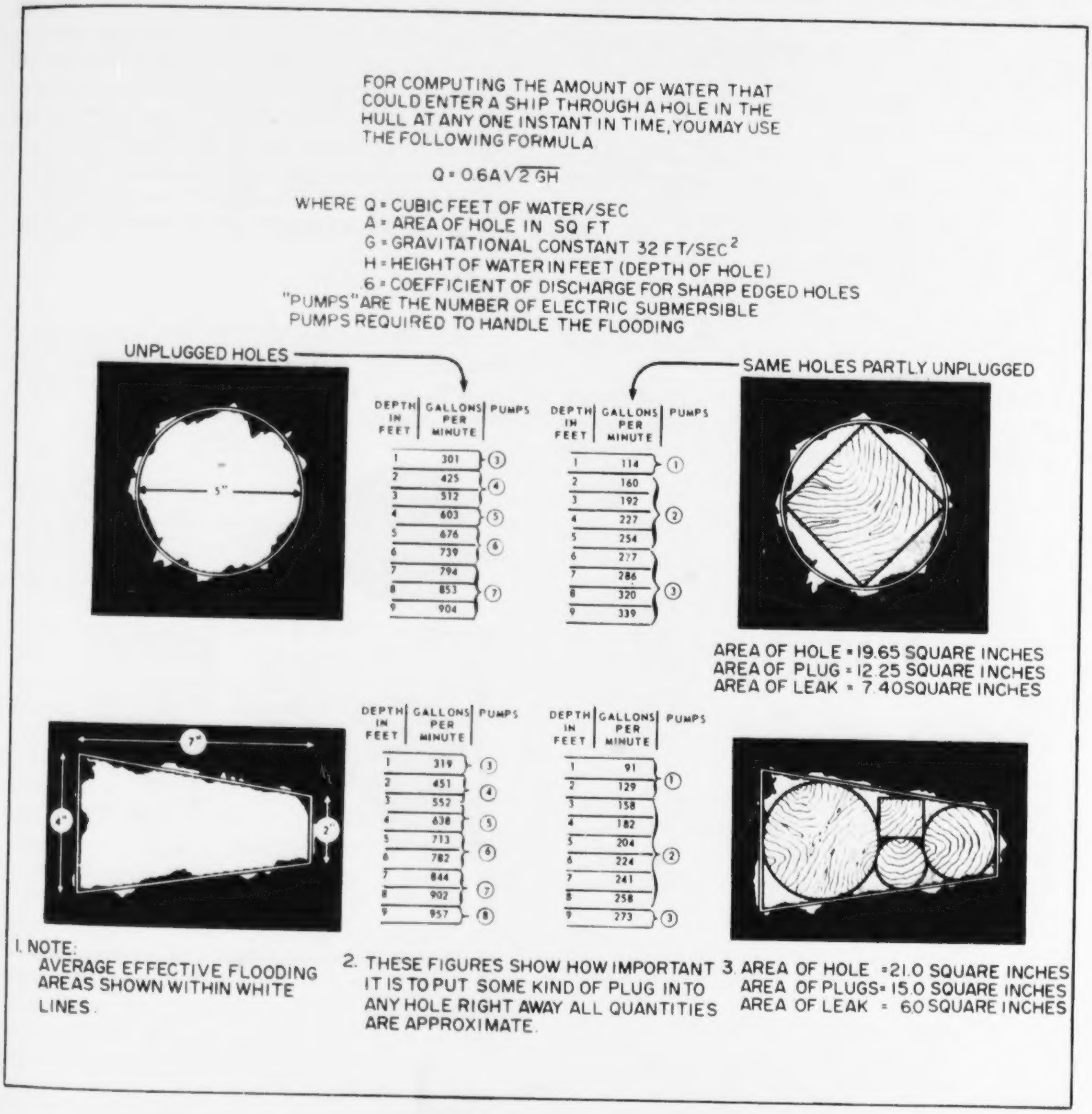
There are two general methods of making temporary repairs to holes in the hull: put something in it or put something over it. In either case, the patches will reduce the area through which water can enter the ship or through which water can pass from one compartment to another.

Plugging

The simplest method of stopping up a fairly small hole is to insert some kind of plug. Plugs made of softwood, such as yellow pine or fir, are quite effective for plugging holes up to about 3 by 3 inches in size. Sometimes you may use these plugs to plug larger holes as well.

The plugging kit consists of the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter
- Softwood plugs; a minimum of 10 plugs in various sizes from 1 inch to 10 inches in diameter



FOR COMPUTING THE AMOUNT OF WATER THAT COULD ENTER A SHIP THROUGH A HOLE IN THE HULL AT ANY ONE INSTANT IN TIME, YOU MAY USE THE FOLLOWING FORMULA

$$Q = 0.6A\sqrt{2GH}$$

WHERE Q = CUBIC FEET OF WATER/SEC
A = AREA OF HOLE IN SQ FT
G = GRAVITATIONAL CONSTANT 32 FT/SEC^2
H = HEIGHT OF WATER IN FEET (DEPTH OF HOLE)
.6 = COEFFICIENT OF DISCHARGE FOR SHARP EDGED HOLES
"PUMPS" ARE THE NUMBER OF ELECTRIC SUBMERSIBLE PUMPS REQUIRED TO HANDLE THE FLOODING

UNPLUGGED HOLES

SAME HOLES PARTLY UNPLUGGED

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	301	③
2	425	④
3	512	
4	603	⑤
5	676	⑥
6	739	
7	794	⑦
8	853	
9	904	

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	114	①
2	160	②
3	192	
4	227	
5	254	
6	277	③
7	286	
8	320	
9	339	

AREA OF HOLE = 19.65 SQUARE INCHES
AREA OF PLUG = 12.25 SQUARE INCHES
AREA OF LEAK = 7.40 SQUARE INCHES

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	319	③
2	451	④
3	552	
4	638	⑤
5	713	⑥
6	782	
7	844	⑦
8	902	
9	957	⑧

DEPTH IN FEET	GALLONS PER MINUTE	PUMPS
1	91	①
2	129	
3	158	②
4	182	
5	204	
6	224	
7	241	
8	258	
9	273	③

1. NOTE: AVERAGE EFFECTIVE FLOODING AREAS SHOWN WITHIN WHITE LINES.

2. THESE FIGURES SHOW HOW IMPORTANT IT IS TO PUT SOME KIND OF PLUG INTO ANY HOLE RIGHT AWAY ALL QUANTITIES ARE APPROXIMATE.

3. AREA OF HOLE = 21.0 SQUARE INCHES
AREA OF PLUGS = 15.0 SQUARE INCHES
AREA OF LEAK = 6.0 SQUARE INCHES

103.98

Figure 7-1.—Flooding effect comparison; unplugged holes vs. partially plugged holes.

- Five pounds of oakum or rags
- One hatchet
- One cold chisel
- One metal caulking iron
- Wedges made of softwood; a minimum of eight wedges, 2 inches by 4 inches and 12 inches long
- One maul or sledge
- One hammer, a minimum 2 pounds in weight
- One crosscut handsaw for cutting wood

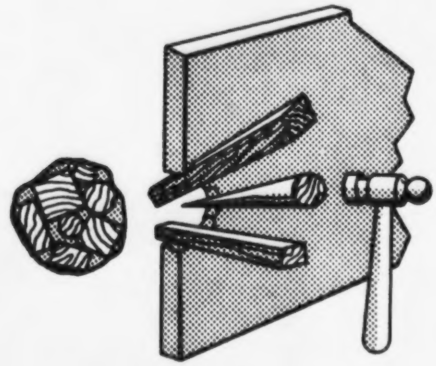
The plugs and wedges may be used individually if they fit the hole. Often, however, it is best to use a combination of conical, square-ended, and wedge-shaped plugs to make a better fit in the hole. One such combination of plugs is shown in figure 7-2.

It is best to wrap each plug with lightweight cloth before inserting it. The cloth tends to keep the plugs in place and fills in some of the gaps between the plugs. In most cases, plugs will not make a watertight fit. However, you can substantially reduce the rate of leakage by using the plugs and then caulking the remaining leaks with rags, oakum, and smaller wedges. Square-ended plugs tend to hold better than conical plugs in holes located in plating that is one-fourth of an inch or less in thickness.

Most wooden plugs are inserted from the inside of the ship. When plugging a hole in this manner, you must contend with the metal edges that are protruding inward. You normally will not have this problem when plugging a hole from the outside of the ship. However, plugs on the outside of the ship cannot be tended easily nor will they hold very well over an extended period of time. If it is necessary to insert the plugs from the outside of the hull, fit the inboard ends of the plugs with screw eyes. A line running from each screw eye and secured to a solid structural member inside the ship will help to keep the plug in place.

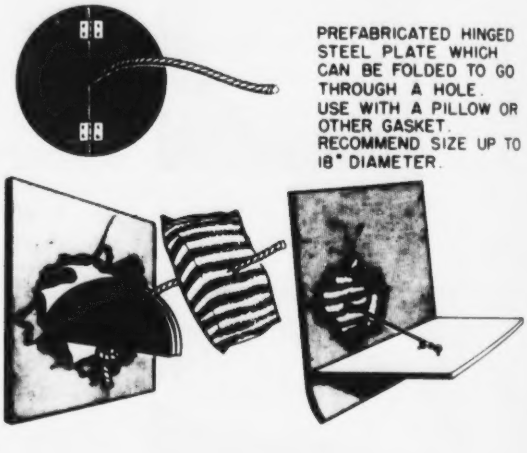
Patching

Box patches are effective for use over holes that have jagged edges projecting inboard. View A of figure 7-3 shows a typical metal box patch;



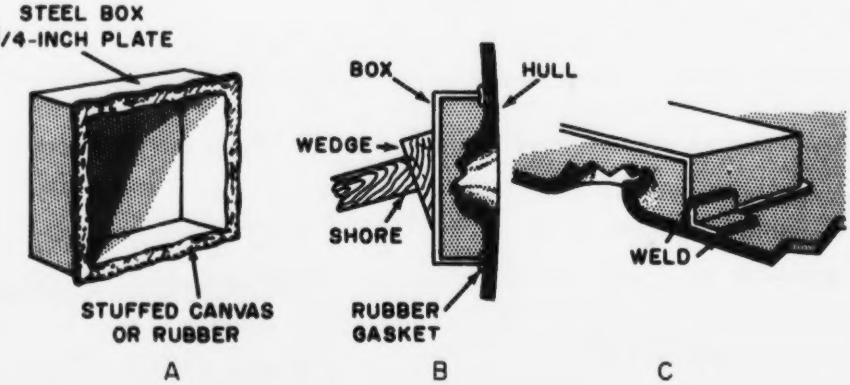
17.7

Figure 7-2.—Combination of plugs used to plug a hole.


PREFABRICATED HINGED STEEL PLATE WHICH CAN BE FOLDED TO GO THROUGH A HOLE.
USE WITH A PILLOW OR OTHER GASKET.
RECOMMEND SIZE UP TO 18" DIAMETER.

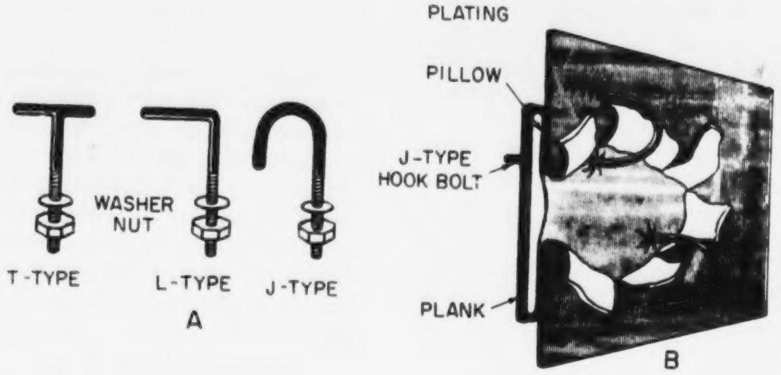
17.8.2

Figure 7-4.—Application of a hinged plate patch.


STEEL BOX 1/4-INCH PLATE
STUFFED CANVAS OR RUBBER
A
BOX
HULL
WEDGE
SHORE
RUBBER GASKET
B
WELD
C

17.8.1

Figure 7-3.—Application of a box patch.



17.8.3
Figure 7-5.—A. Types of hook bolts. B. Use of hook bolts in applying a patch.

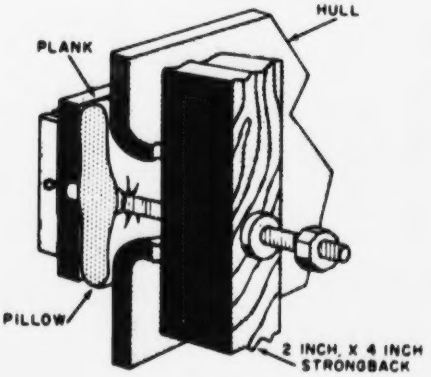
view B shows a metal box patch held in place by shoring; and view C shows a metal box patch welded in place over a hole that has jagged edges.

A hinged patch is designed for use over relatively small holes. This patch has no vertical support to hold it in place. Figure 7-4 shows a hinged plate patch before, during, and after installation.

A hook bolt is a long bolt that is usually fabricated from round steel stock. Hook bolts come in a variety of diameters and shapes. The head is shaped so that the bolt can be hooked to the plating through which the head has been inserted. Figure 7-5 shows T-shaped, L-shaped, and J-shaped hook bolts and how the hook bolts are used to apply a patch. The long shanks are threaded and are provided with nuts and washers. Wood (or sometimes steel) strongbacks are used with hook bolts.

To use a hook bolt, insert the head end of the bolt through the hole in the hull. Rotate or adjust the bolt until it cannot be pulled back through the hole. Slide a pad or gasket that is backed by a plank or strongback over the bolt. Secure the patch by tightening the nut. Generally, these bolts are used in pairs. Hook bolts can be used with a variety of patches and in various combinations.

The folding T-shaped hook bolt has a hinge where the shank joins the crosspiece. This bolt can be folded and inserted through a small hole. When the bolt is pulled back, the crosspiece catches on the hull plating. By using this bolt, a crew member standing inside the ship can put a patch on either the inside or the outside of the ship. By using a retaining line on the bolt, a strongback and a pillow can be threaded over the line and the entire patch folded and placed through the hole. When the line is hauled in, the patch fits against the ship. The patch can be re-adjusted to give a tighter fit. It is also possible to push the pillow and plate over the shank inside the ship to make an inside patch. Nuts and washers are provided to hold and tighten a patch; often large wing nuts are used. Figure 7-6 shows one way in which a folding T-shaped hook bolt can be used to secure a patch.



103.100
Figure 7-6.—One method of installing a folding T patch.

Ordinary feather pillows have a tendency to ball up when they are wet and do not provide a uniform surface when used to patch holes. For this reason some ships carry special pillows (fig. 7-7) made of canvas and oakum.

You will frequently find it necessary to improvise patches by using whatever material is handy. This calls for skill and a certain amount of imagination. Hinged or folding prefabricated patches are usually the easiest to use, and in many cases, they are the most effective. But if they are not available, you will need to improvise patches.

CAULKING JOINTS

A riveted joint basically is not watertight or oiltight because the surfaces or edges that are held together are not machined or ground. Therefore, the riveted joints or boundaries tend to loosen from the shock of gunfire, collision, vibration, explosion, and rocking of the ship as a result of high-speed maneuvering. Repairs to this type of damage are usually made by caulking the loosened joint. These repairs must be made as soon as defects are discovered.

In caulking, a thin fin of metal is usually sprung from the baseplate or structure by using a pneumatically driven chisel, caulking tool, or hammer. The general procedure for caulking a riveted joint is illustrated in figure 7-8.

SHORING

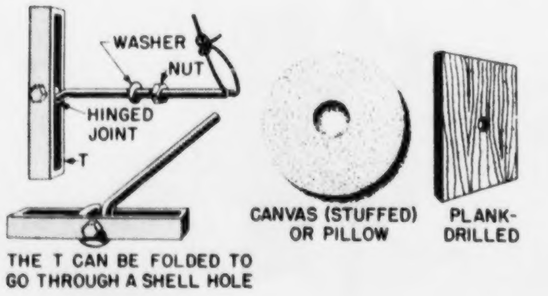
Shoring is often used aboard ship to support ruptured decks, to strengthen weakened bulkheads and decks, to build up temporary decks and bulkheads against the sea, to support hatches and doors, and to provide support for equipment that has broken loose.

Knowing when to shore is a problem that cannot be solved by the application of any one set of rules. Sometimes the need for shoring is obvious. Examples are loose machinery or damaged hatches. However, dangerously weakened supports under guns or machinery may not be so readily noticed. Although shoring is sometimes done when it is not really necessary, the best general rule is this: *If in doubt, shore it.*

SHORING MATERIALS

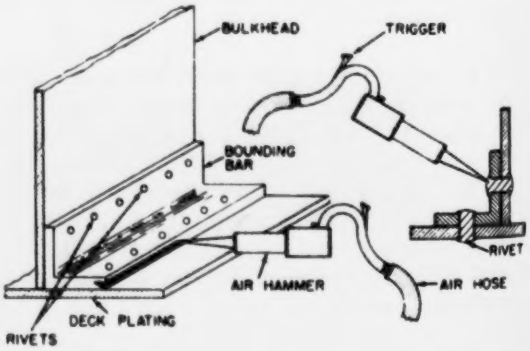
The basic materials required for shoring are shores, wedges, sholes, and strongbacks. A *shore* is a portable beam. A *wedge* is a block, triangular on the sides and rectangular on the butt end. A *shole* is a flat block that may be placed under the end of a shore to distribute pressure. A *strongback* is a bar or beam of wood or metal which is used to distribute pressure or to serve as an anchor for a patch. The strongback is often shorter than a shore.

Many other items are used in connection with shoring. They include wooden battens, claw hammers, mauls and sledges, handsaws, mattresses, pillows, axes, hatchets, wood clamps, chain falls, electric welding machines, oxyacetylene cutting outfits, cold chisels, wood chisels, nails, wooden plugs, packing sheets, turnbuckles, screw jacks, hydraulic jacks, bolts, nuts, and washers. The COSAL lists the quantity of such gear that each ship should carry on board.


WASHER
NUT
HINGED JOINT
T
THE T CAN BE FOLDED TO GO THROUGH A SHELL HOLE
CANVAS (STUFFED) OR PILLOW
PLANK-DRILLED

17.8.4

Figure 7-7.—Materials used in assembling a folding T patch.



103.101

Figure 7-8.—Caulking a riveted joint.

Shores

The best woods available for shores are Douglas fir and yellow pine. Hemlock and spruce may also be used. However, they are not as good because they are not as strong. Any wood used for shores should be straight grained and relatively free of knots and cracks. Green timbers are not as strong as cured timbers. If it is necessary to use a poor quality wood, use more shores than would be required for shores of a better quality wood. Shores authorized for shipboard use are treated with a fire-resisting chemical. They should NEVER be painted with an ordinary paint.

The length of a shore in use should never be more than 30 times its minimum thickness. Thus a shore that is 4 by 4 inches should not be any longer than 10 feet. A shore that is 6 by 6 inches should not be any longer than 15 feet. A shore that is 4 by 6 inches should not be longer than 10 feet. The shorter the shore is in relation to its thickness, the greater the weight it will support. Shores should normally be carried aboard ship in 16-foot and 18-foot lengths that can be cut to the required lengths when needed.

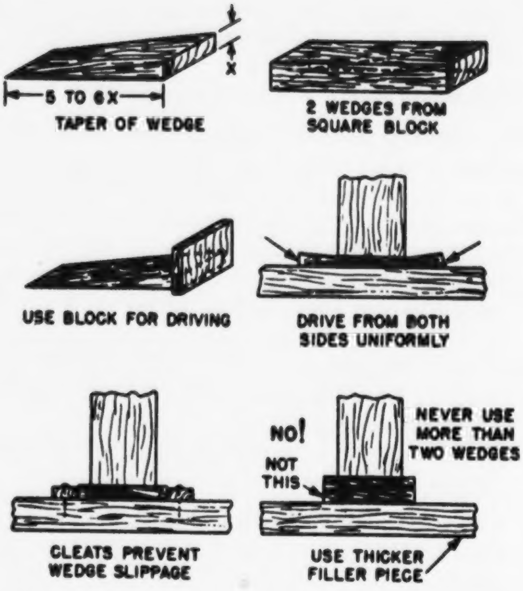
Wedges

Wedges should be of softwood, preferably fir or yellow pine. They should be cut with a coarse saw and left rough and unpainted. This allows the wedges to absorb water and hold better than if they are smoothed or painted. A few hardwood wedges should be kept on hand for special uses, since they resist crushing better. However, hardwood wedges cannot be used for all shoring because they have a tendency to work loose. When hardwood wedges are used, they must be checked frequently.

Wedges should be approximately the same width as the shores with which they are used. They may be made with various angles at the leading edge, but a blunt wedge will not hold as well as a sharp one. A wedge should be about six times as long as it is thick. Thus a wedge to be used with a shore that is 4 by 4 inches should be about 4 inches wide, 2 inches thick, and 12 inches long. Figure 7-9 illustrates some wedges and shows how they are used.

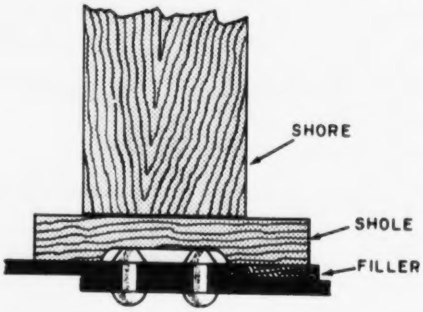
Sholes

Sholes should be made of Douglas fir or yellow pine planks that are at least 1 inch thick and 8 to 12 inches wide. Wider sholes can be made by nailing cleats across two or more widths of planking. A single plank may have to be cleated at the ends to keep it from splitting. Do not fabricate sholes in advance of the actual need for them; prefabricated sholes would probably not fit where they are needed. The use of a shole is illustrated in figure 7-10.


X
5 TO 6X
TAPER OF WEDGE
2 WEDGES FROM SQUARE BLOCK
USE BLOCK FOR DRIVING
DRIVE FROM BOTH SIDES UNIFORMLY
CLEATS PREVENT WEDGE SLIPPAGE
NO!
NOT THIS
NEVER USE MORE THAN TWO WEDGES
USE THICKER FILLER PIECE

103.102

Figure 7-9.—Wedges.



103.103

Figure 7-10.—Use of a shole.

Strongbacks

All or part of an ordinary shore may be used to make a strongback. Shoring scraps should be kept for use as strongbacks and short shores. Heavy planks, steel bars, angle irons, and pipe can also be used as strongbacks (fig. 7-6).

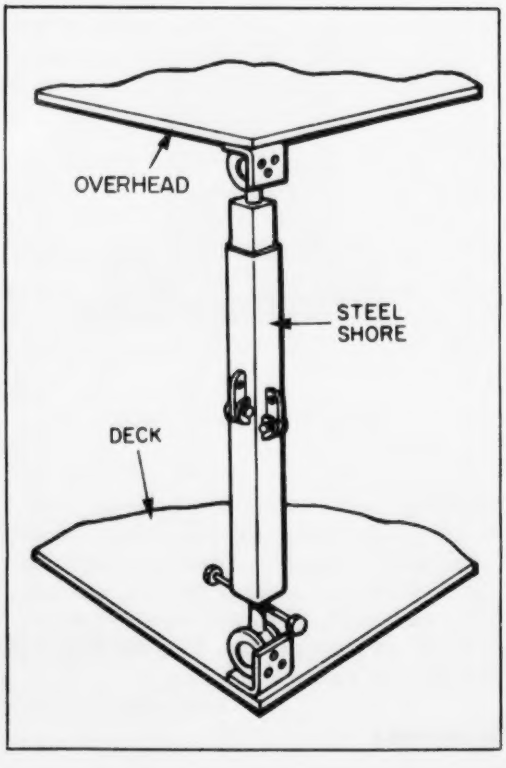
Metal Shores

Several types of telescopic steel shores may be used to make temporary repairs. Not all of these types have proven to be satisfactory for immediate repairs. The metal shores normally will have pins or locking devices and are fitted with a hinged shoe at each end. The pins or locking devices are used to adjust the length of the shore. The hinged shoe may be easily adjusted to any angle and then welded in place. The newer types of metal shores (fig. 7-11) are also fitted with screw jacks or swivel (ball and socket) bases.

The newer steel shores are available in the following models:

- Model 3-5 is adjustable from a minimum of 3 feet, plus or minus 3 inches, to a maximum of 5 feet, plus or minus 3 inches. It will support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 12,000 pounds when fully extended.

- Model 6-11 is adjustable from a minimum of 6 feet, plus or minus 3 inches, to a maximum of 11 feet, plus or minus 3 inches. It will also support a maximum vertical load of 20,000 pounds when closed to within 1 inch of the screw jack. It will support a maximum vertical load of 6,000 pounds when fully extended.



8.507

Figure 7-11.—Steel shore supporting overhead deck or load.

These shores consist of two telescoping, square, steel tubes. Four spring-loaded locking devices, a swivel baseplate, and a screw jack are on the outer tube. A swivel baseplate is on one end of the inner tube. Each side of the shore has a spring-loaded locking device. Each locking device is on the same plane as the locking device on the opposite of it. However, there is a 2 1/4-inch offset of the adjacent locking devices.

The steel shores must be maintained in good operational condition. The tubes must slide easily, and the swivel joints must move freely. The threads of the screw jack must not have any paint on them. Both the swivel joints and the screw jack threads are to be clean and greased. All of the holes and slots are to be open and free of excess paint.

Steel wedges are more valuable for prying things apart than for actual shoring. Steel wedges may be used in conjunction with wooden wedges to take some of the wear and pressure off of the wooden wedges. Steel wedges can also be welded into place when making semipermanent repairs.

Steel sholes are better than wooden sholes for use under the ends of iron pipe that is being used as temporary stanchions. The metal pipe would cut through wooden sholes.

Although steel bars, angle irons, and pipe can be used for strongbacks, their tendency to spring back and forth under variable loads must be considered. These materials can also be used for making semipermanent repairs when time is available.

SHORING KIT

Shoring kits are small enough to go through scuttles and other small openings. A shoring kit contains the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter

- One 5-pound maul

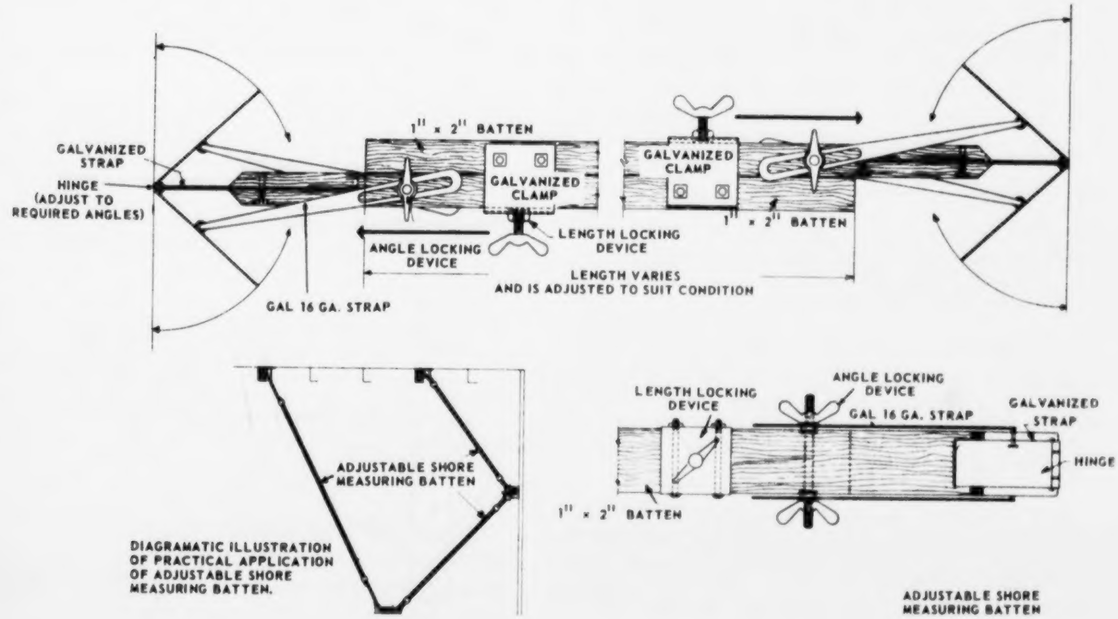
- One 10-pound sledge
- One 8-point crosscut handsaw
- One 10-foot metal tape rule
- One 50-foot metal tape rule
- One claw hammer
- One hatchet
- One 3/4-inch cold chisel
- One 1-inch wood chisel
- Eight adjustable clamps: four 6 inches and four 8 inches in nominal size
- One caulking hand tool
- One 24-inch carpenter's square
- One electric hand lantern
- Eight 2- by 4-inch softwood wedges
- One bag of nails; two pounds each of 20d and 30d common nails
- Five pounds of oakum or rags
- Five pounds of sand
- One section of shoring; 4 inches by 4 inches by 10 feet

MEASURING AND CUTTING SHORES

The most rapid and accurate way to measure a shore for cutting is to use an adjustable shoring batten similar to the one shown in figure 7-12. These battens can be made up from items carried aboard ship. Each repair party locker is required to have a shoring batten.

To use the shoring batten, extend it to the required length and lock it with the thumbscrews on the length locking device. Then measure the angles of cut by adjusting the hinged metal pieces at the ends of the batten. Lock the angle locking devices in place. Lay the batten along the shore. Mark and cut the timber to the proper length and angle. Shores should be cut one-half of an inch shorter than the measured length to allow space to install wedges.

If a shoring batten is not available, measure the shores for length by using a folding rule or


GALVANIZED STRAP
HINGE (ADJUST TO REQUIRED ANGLES)
1" x 2" BATTEN
GALVANIZED CLAMP
GALVANIZED CLAMP
ANGLE LOCKING DEVICE
LENGTH LOCKING DEVICE
1" x 2" BATTEN
LENGTH VARIES AND IS ADJUSTED TO SUIT CONDITION
GAL 16 GA. STRAP
ADJUSTABLE SHORE MEASURING BATTEN
DIAGRAMATIC ILLUSTRATION OF PRACTICAL APPLICATION OF ADJUSTABLE SHORE MEASURING BATTEN.
LENGTH LOCKING DEVICE
ANGLE LOCKING DEVICE
GAL 16 GA. STRAP
GALVANIZED STRAP
HINGE
1" x 2" BATTEN
ADJUSTABLE SHORE MEASURING BATTEN

103.104

Figure 7-12.—Shoring batten.

a steel tape and a carpenter's square. The step-by-step procedure for measuring shores in this way, as shown in figure 7-13, is as follows:

1. Measure distance A from the center of the strongback to the deck. This distance is known as the *rise*. Then measure distance B from the edge of the anchorage to the bulkhead. This distance is known as the *uncorrected run*. Subtract the thickness of the strongback from measurement B. This distance is now known as the *corrected run*.

2. Lay off the measurements A and B on a carpenter's square, using the ratio of 1 inch to 1 foot. Rule measurement is taken to the nearest one-sixteenth of an inch. To maintain the 1-inch to 1-foot ratio, use the following conversion table:

ACTUAL RULE MEASUREMENT	MEASUREMENT ON CARPENTER'S SQUARE
3/4 inch	1/16 inch
1 1/2 inches	1/8 inch
2 1/4 inches	3/16 inch
3 inches	1/4 inch
3 3/4 inches	5/16 inch
4 1/2 inches	3/8 inch
5 1/4 inches	7/16 inch
6 inches	1/2 inch
6 3/4 inches	9/16 inch
7 1/2 inches	5/8 inch
8 1/4 inches	11/16 inch
9 inches	3/4 inch
9 3/4 inches	13/16 inch
10 1/2 inches	7/8 inch
11 1/4 inches	15/16 inch
12 inches	1 inch

3. Measure the diagonal distance between A and B. In the example given in figure 7-13, this distance is 7 7/8 inches. Because of the 1-inch to 1-foot ratio, the distance in feet would be 7 7/8 feet or 7 feet 10 1/2 inches.

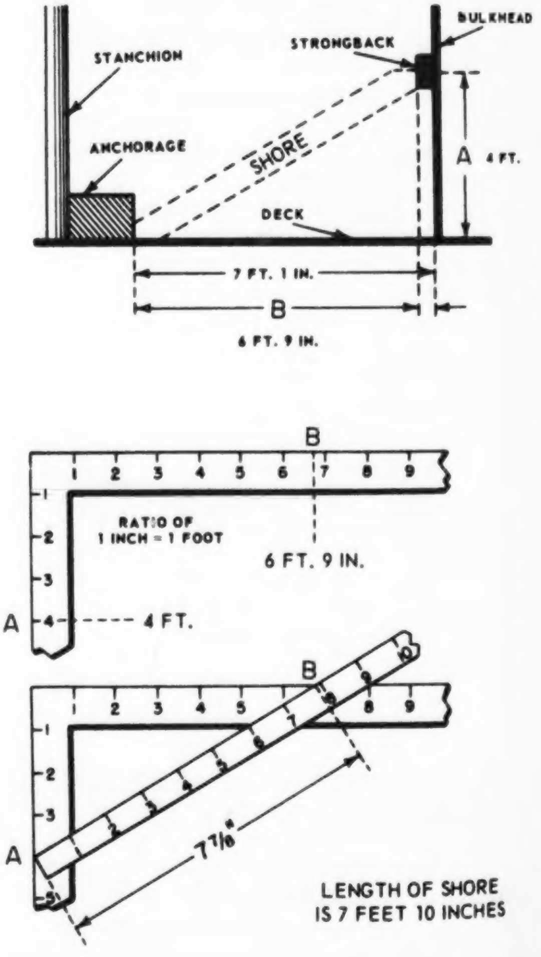
4. Subtract one-half of an inch, since shores should be cut one-half of an inch shorter than the measured distance to allow for the required wedges. Thus the final length of the shore should be 7 feet 10 inches.

The carpenter's square may also be used to measure the angles of cut and to mark the shore for cutting (fig. 7-14). Using the same measurements as in the previous example, proceed as follows:

1. Lay the square along the shore, as shown in part 1 of figure 7-14, making sure that the measurements 4 inches and 6 3/4 inches lie along the same line. Cut the shore to this line.

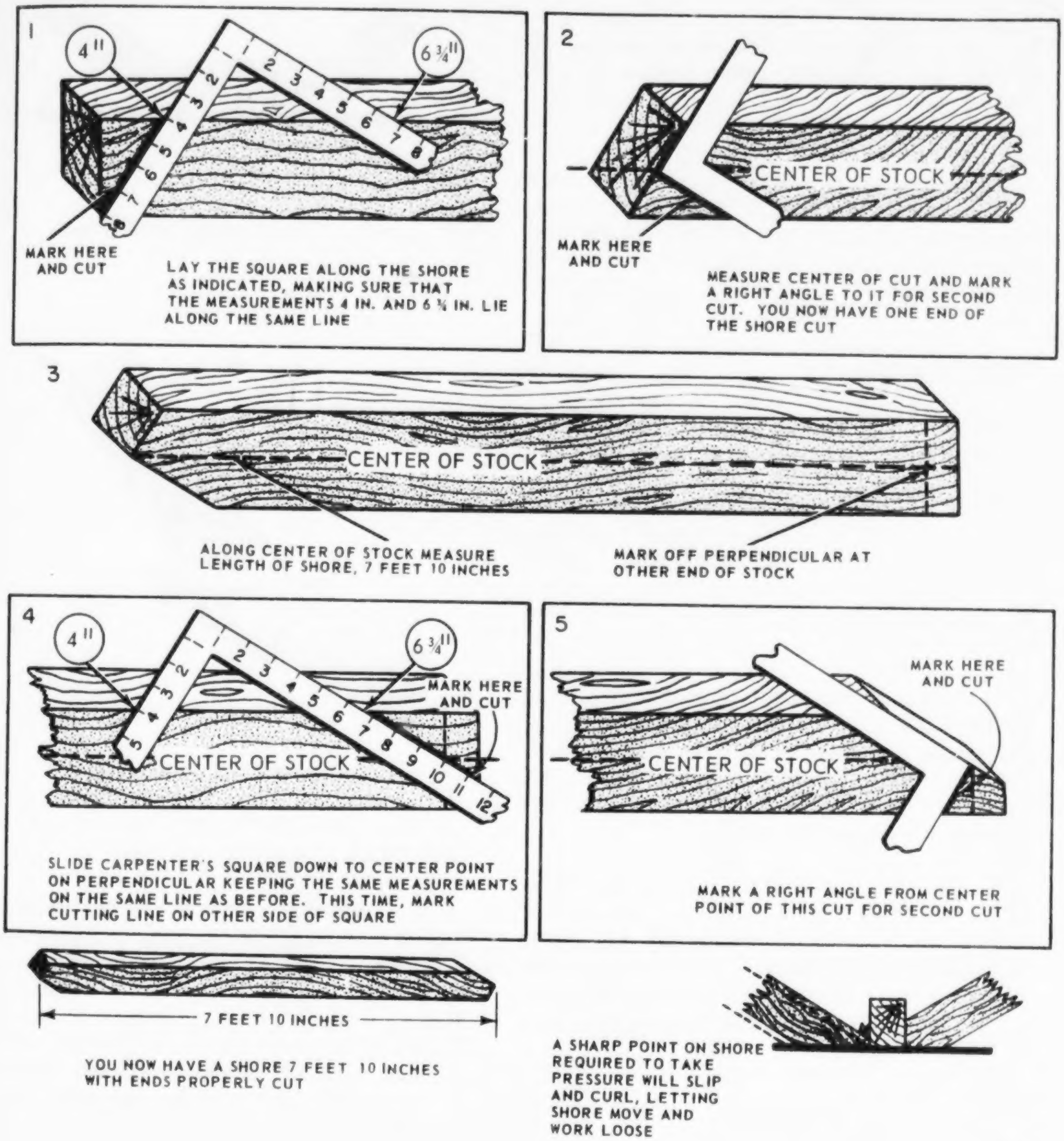
2. Measure the center of the cut and mark a right angle to it for the second cut. Saw to the line. You have now completed cutting one end of the shore.

3. Along the center of the timber, measure the length of the shore (7 feet 10 inches) and mark off a perpendicular line at the other end of the shore.



103.105

Figure 7-13.—Measuring length of shore.


1
4"
6 ¾"
MARK HERE AND CUT
LAY THE SQUARE ALONG THE SHORE AS INDICATED, MAKING SURE THAT THE MEASUREMENTS 4 IN. AND 6 ¾ IN. LIE ALONG THE SAME LINE
2
CENTER OF STOCK
MARK HERE AND CUT
MEASURE CENTER OF CUT AND MARK A RIGHT ANGLE TO IT FOR SECOND CUT. YOU NOW HAVE ONE END OF THE SHORE CUT
3
CENTER OF STOCK
ALONG CENTER OF STOCK MEASURE LENGTH OF SHORE, 7 FEET 10 INCHES
MARK OFF PERPENDICULAR AT OTHER END OF STOCK
4
4"
6 ¾"
MARK HERE AND CUT
CENTER OF STOCK
SLIDE CARPENTER'S SQUARE DOWN TO CENTER POINT ON PERPENDICULAR KEEPING THE SAME MEASUREMENTS ON THE SAME LINE AS BEFORE. THIS TIME, MARK CUTTING LINE ON OTHER SIDE OF SQUARE
5
MARK HERE AND CUT
CENTER OF STOCK
MARK A RIGHT ANGLE FROM CENTER POINT OF THIS CUT FOR SECOND CUT
7 FEET 10 INCHES
YOU NOW HAVE A SHORE 7 FEET 10 INCHES WITH ENDS PROPERLY CUT
A SHARP POINT ON SHORE REQUIRED TO TAKE PRESSURE WILL SLIP AND CURL, LETTING SHORE MOVE AND WORK LOOSE

103.106

Figure 7-14.—Cutting the angles of a shore.

4. Slide the carpenter's square down to the center point on the perpendicular. Keep the same measurements on the same line as before in step 1. This time, mark the cutting line on the other side of the square.

5. Mark a right angle from the center point of this cut for the second cut. Make your cuts. You now have a shore that is 7 feet 10 inches long with the ends properly cut to fit the measurements.

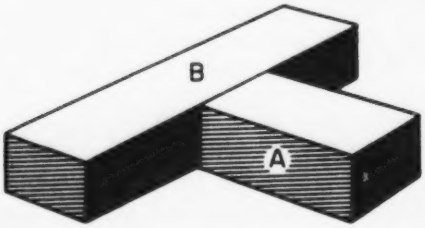
The proper cutting of shores is an important part of any shoring operation. Shores are usually cut with a hand-held circular saw. However, you may use an ordinary carpenter's handsaw. All repair party personnel should be instructed in the correct use of these tools. Shores that are poorly cut may cause delay in completing the shoring job and may cause failure of the shoring structure. You will find that the wedges and shores will not fit properly if the shores are not cut correctly. Wet timbers are particularly hard to cut unless the proper methods of sawing are used. In cutting heavy shores, a lumberjack crosscut saw will save a good deal of time. Chisels, axes, and hatchets are also used to cut shores.

TRIMMING SHORES

Shores must be trimmed to fit the shoring structure. The trimming must be done in such a way as to prevent splitting or chipping of the shores. If shore A in figure 7-15 is to fit against a plane surface of shore B and if it must take a load in compression, the end of shore A must be cut square and perpendicular to its long axis.

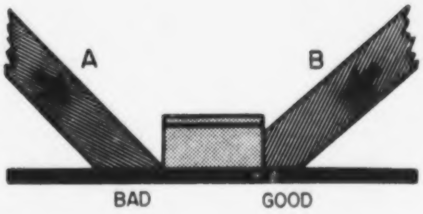
A sharp point must never be used when a shore will be required to withstand pressure. A pointed end will slip and curl and allow the shore to work loose and move. Figure 7-16 shows correct and incorrect ways to trim shores to present a flat surface at each pressure area.

Shores are sometimes notched at the end to fit against other shores. However, this method should not be used if you expect any great pressure. A safer method is to cut a socket in the side of one shore and fit the butt of the other shore into the socket. This method is illustrated in figure 7-17.



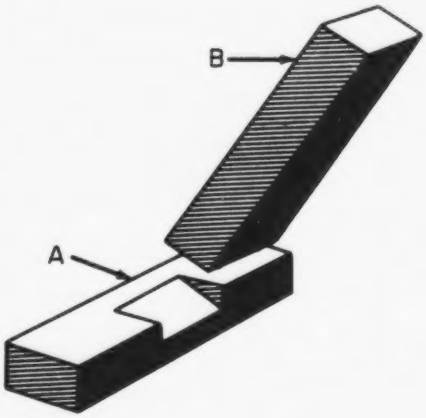
80.205

Figure 7-15.—Trimming shore to shore.



80.206

Figure 7-16.—Trimming shore to deck.



80.207

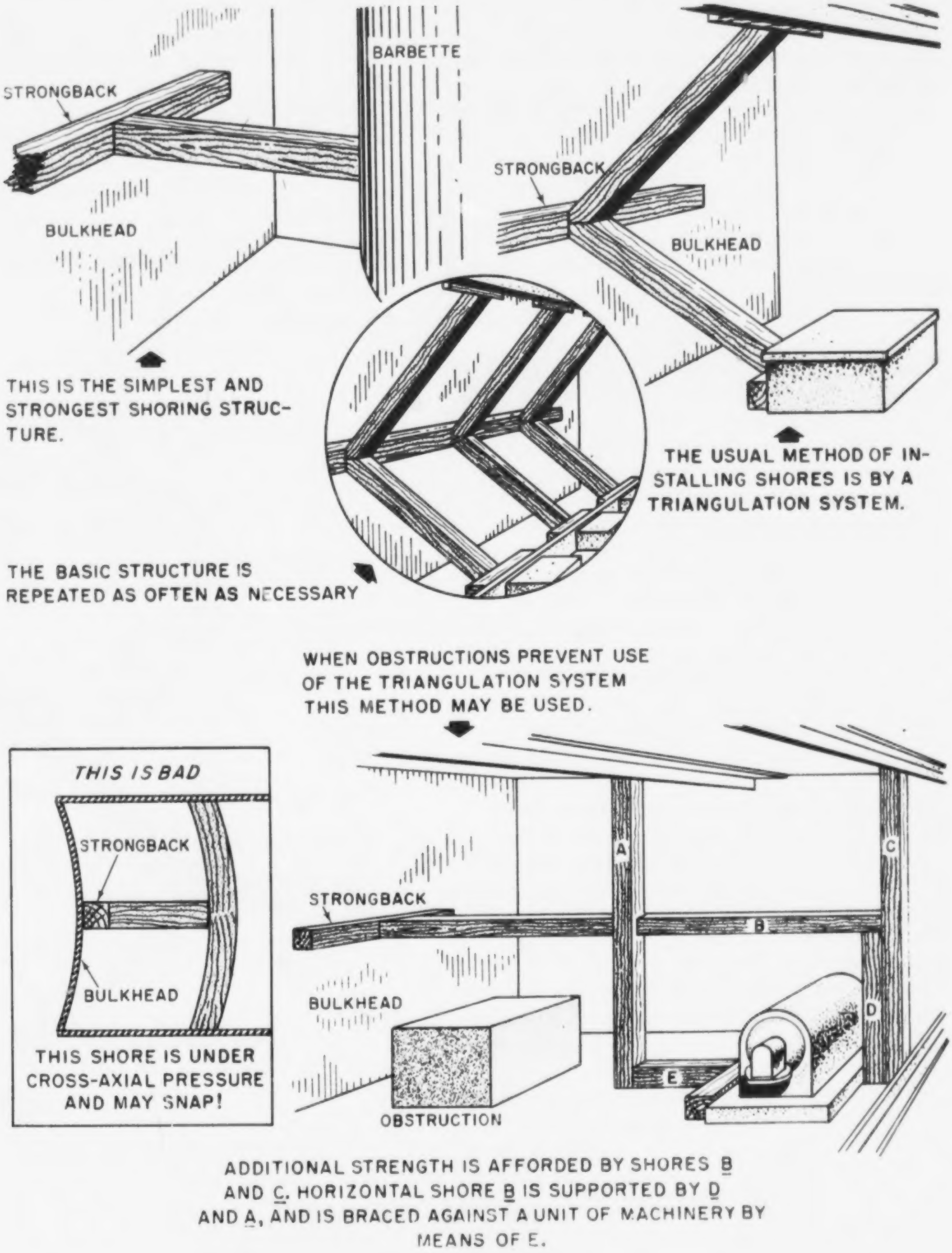
Figure 7-17.—Socket cut in shore.

GENERAL SHORING RULES

Most shoring is done to support bulkheads that are endangered by structural damage or weakness caused by a hit or by the pressure of flooding water. The pressure on the bulkhead of a flooded compartment is tremendous. Expert shoring is required to hold such bulkheads in place. Some of the general rules to remember in connection with shoring bulkheads are as follows:

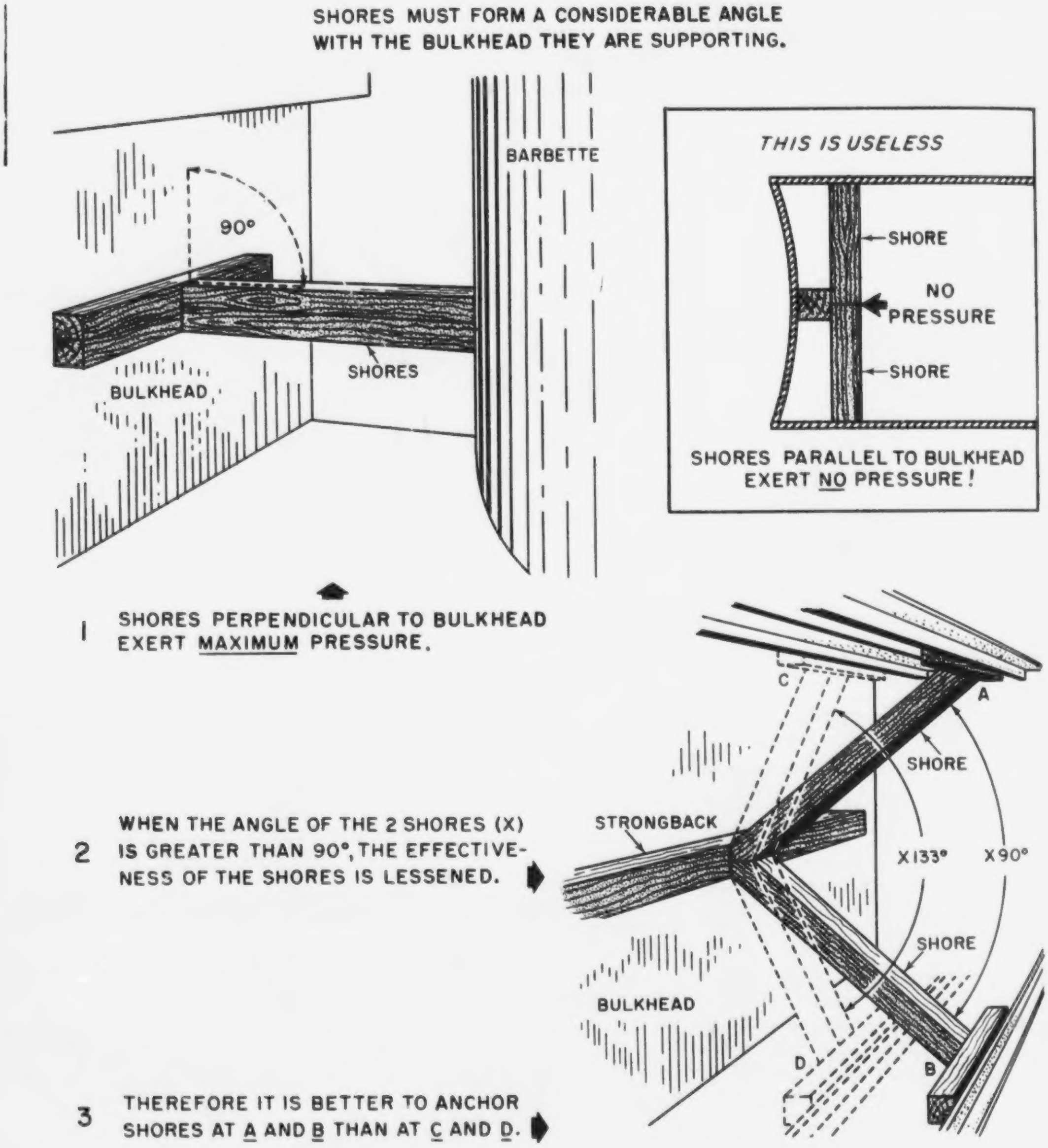
- Always allow a large margin of safety. Use MORE shores than you think you need, rather than fewer.

- Spread the pressure. Make full use of strength members by anchoring shores against beams, stringers, frames, stiffeners, stanchions, barbettes, and so forth. Place the legs of the shoring against the strongback at an angle of 45° or 90° if at all possible. Figure 7-18 illustrates the


BARBETTE
STRONGBACK
BULKHEAD
THIS IS THE SIMPLEST AND STRONGEST SHORING STRUCTURE.
STRONGBACK
BULKHEAD
THE USUAL METHOD OF INSTALLING SHORES IS BY A TRIANGULATION SYSTEM.
THE BASIC STRUCTURE IS REPEATED AS OFTEN AS NECESSARY
WHEN OBSTRUCTIONS PREVENT USE OF THE TRIANGULATION SYSTEM THIS METHOD MAY BE USED.
THIS IS BAD
STRONGBACK
BULKHEAD
THIS SHORE IS UNDER CROSS-AXIAL PRESSURE AND MAY SNAP!
STRONGBACK
A
B
C
D
E
BULKHEAD
OBSTRUCTION
ADDITIONAL STRENGTH IS AFFORDED BY SHORES B AND C. HORIZONTAL SHORE B IS SUPPORTED BY D AND A, AND IS BRACED AGAINST A UNIT OF MACHINERY BY MEANS OF E.

17.10

Figure 7-18.—Shoring against horizontal pressure.



SHORES MUST FORM A CONSIDERABLE ANGLE WITH THE BULKHEAD THEY ARE SUPPORTING.

1 SHORES PERPENDICULAR TO BULKHEAD EXERT MAXIMUM PRESSURE.

THIS IS USELESS

SHORES PARALLEL TO BULKHEAD EXERT NO PRESSURE!

2 WHEN THE ANGLE OF THE 2 SHORES (X) IS GREATER THAN 90°, THE EFFECTIVENESS OF THE SHORES IS LESSENED.

3 THEREFORE IT IS BETTER TO ANCHOR SHORES AT A AND B THAN AT C AND D.

90°
BARBETTE
SHORES
BULKHEAD
SHORE
NO PRESSURE
SHORE
STRONGBACK
C
A
SHORE
X133°
X90°
SHORE
BULKHEAD
D
B

17.10

Figure 7-19.—Shoring angles.

simplest and strongest shoring structure; figure 7-19 shows shoring angles.

- Do not attempt to force a warped, sprung, or bulged bulkhead back into place. Place the shoring so that it will hold the bulkhead in its warped or bulging position.

- When possible, strengthen the main shores with auxiliary shores.

The same general rules apply to shoring a hatch or a door. However, the entire hatch or door should be shored and the pressure should be spread over both the hatch cover or door and the supporting structure, as shown in figure 7-20. Remember that hatches and doors are the weakest part of the bulkhead or deck in which they are installed. Shoring doors and hatches may be complicated by the presence of scuttles and quick-acting handwheels. In this situation, it will be necessary to arrange the shores in such a way as to clear the wheel. A basic rule is to put as many points of pressure on the closure as there are dogs on the closure.

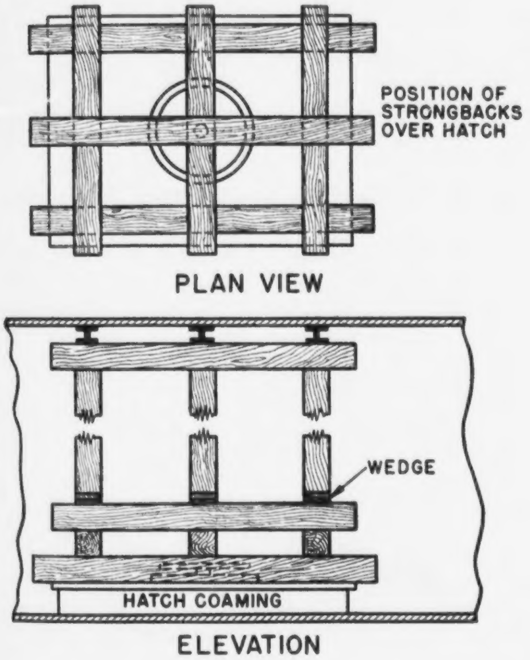


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Figure 7-20.—Shoring a hatch.

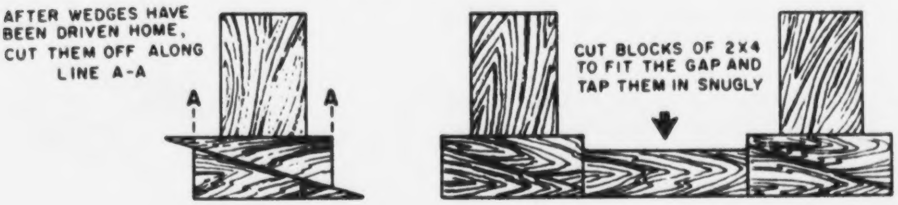
The success of any shoring job depends largely on the way in which the timbers are wedged. As the shoring job progresses, check carefully to ensure that all of the wedges are exerting about the same amount of pressure on the member being shored. Use as few wedges as possible to obtain satisfactory results. Always drive the wedges in uniformly from both sides so that the shore end will not be forced out of position. Lock the wedges in place so that they will not work loose and cause the shoring to slip. Figure 7-21 shows one method of locking wedges in place.

PRACTICE SHORING

If you are in charge of a shoring detail and if you have enough shores on board, it would be a good idea to give your shoring detail personnel some practice in shoring. As they put up the shoring, explain what they are doing right and what they are doing wrong and, in each case, why it is right or wrong. Ensure that they understand the principles of spreading the pressure, and why a shore in cross-axial pressure might snap. Be sure that they learn how to measure shores and how to cut them correctly before they actually do the cutting.

If possible, obtain permission to put the shoring up in a compartment where it may be left for a few days. This will allow other personnel to inspect it and indirectly learn something about how to shore.

When doing practice shoring jobs, be careful not to cut the shores more than necessary. You will seldom have an oversupply of shores aboard ship. If you do not have spare shores for practice jobs, use strips and battens to build mock-ups and models to scale. Although models are not as effective for training as actual practice shoring jobs, they do have some training effect. One advantage of the models is that you can work out some rather elaborate shoring problems with


AFTER WEDGES HAVE BEEN DRIVEN HOME, CUT THEM OFF ALONG LINE A-A
A
A
CUT BLOCKS OF 2X4 TO FIT THE GAP AND TAP THEM IN SNUGLY

28.271

Figure 7-21.—Locking wedges in place.

them. Also, the models can be kept and used again and again for training purposes.

After the shoring practice has been completed (whether using a model or full-size shores), it is a good idea to have the shoring detail personnel discuss the job and make comments on the good and bad points of the shoring. Some of the questions to be brought up in this discussion include the following:

- Is the shoring job effective?
- Could it be made just as effective with fewer shores?
- Should more shores have been used?
- Is the shoring pressure correctly spread?
- Is the wedging done correctly?

This type of questioning and discussion can be effective as a device for making sure that everyone involved really understands the problems and principles of shoring.

EMERGENCY PIPE PATCHING

Damaged piping systems are another source of flooding in compartments. The pipes may have small holes, cracks, or be totally severed. Normally, you will want to isolate the damage by securing the cutout valves on each side of the damaged section of piping. However, whether the piping may be secured, and the amount of time it can be secured, will depend on the service the system provides. A saltwater flushing line may stay secured until repairs can be made after vital repairs have been completed. However, you will need to make temporary repairs on some lines immediately to put the system back into service. Firemain piping, fuel oil lines, and chill water cooling lines to electronic spaces should be repaired as soon as possible.

Small holes in some piping may be temporarily repaired if you drill the hole out, thread it, and then insert a machine screw. Other holes will require a different means of patching. You may use a jubilee pipe patch, a soft patch, or a metallic pipe patch. The materials for all of these repairs are found in the pipe-patching kit.

Pipe-patching kits are available in the ship's repair lockers. Each kit contains the following items:

- A canvas bag, with a carrying strap, approximately 30 inches deep and 12 inches in diameter
- Several small softwood plugs and wedges; enough to plug 24 inches of split
- Approximately 8 square feet of 1/8-inch rubber gasket
- Approximately 8 square feet of canvas
- One hundred and fifty feet of marlin
- Three pounds of oakum or rags
- One hacksaw with a minimum of six spare blades
- One hatchet or wood chisel
- One hammer, 2 pounds in weight
- A pair of scissors or a knife for cutting the materials
- A banding kit

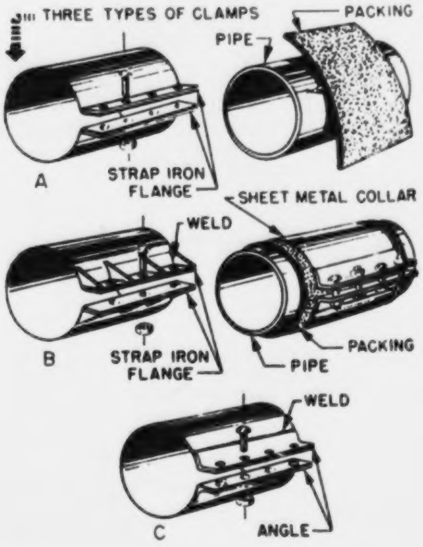


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Figure 7-22.—Jubilee pipe patches.

- A metallic pipe repair kit
- Jubilee pipe patches; a minimum of five in various sizes

JUBILEE PIPE PATCH

The jubilee pipe patch (fig. 7-22) is a modification of a commercial hose clamp. Periodically, you may purchase heavy-duty jubilee pipe patches through the supply system. However, if you cannot purchase them, you can manufacture them yourself.

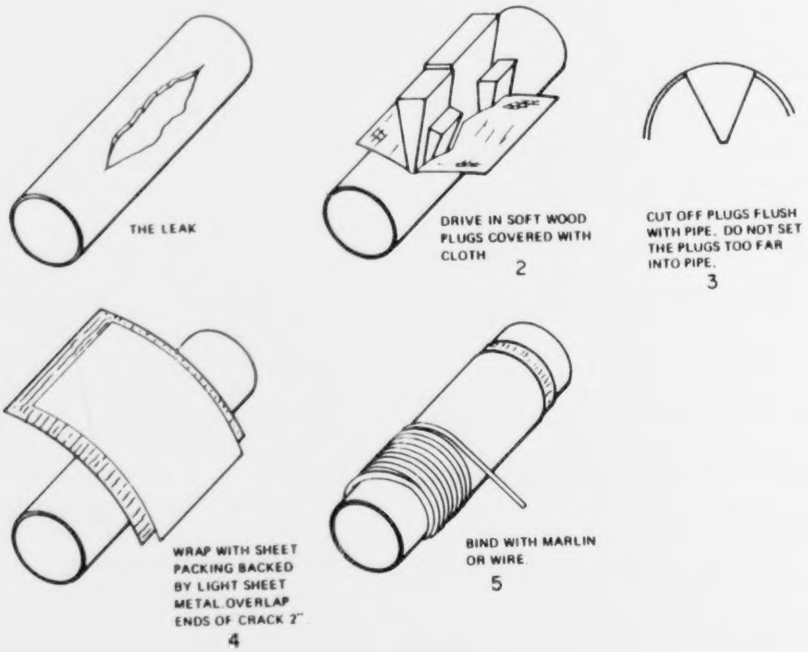
To manufacture a jubilee pipe patch, roll a piece of sheet metal into a cylinder. Bend a tab on each edge to form a flange. The flanges may be reinforced by welding on strips of scrap iron. Drill three to five holes through both flanges for the securing bolts. To keep the flange faces somewhat parallel when under pressure, weld small braces from the flanges to the back of the patch.

Use a thick gage sheet metal that will withstand pressure but can also be sprung open enough to be put over the pipe. To use the jubilee pipe patch, put a piece of rubber or gasket material over the hole. It should be large enough to cover and overlap the damage at least 2 inches on all sides. Slip the jubilee pipe patch over the rubber or gasket material. Insert the bolts into the holes and secure them in place. The jubilee pipe patch can withstand 100 pounds of pressure.

SOFT PATCH

Small holes or cracks in low-pressure (150 psi) piping can often be repaired by applying a soft patch (fig. 7-23). When it is possible, reduce the area of the hole first by driving in softwood plugs and wedges as necessary. Do not drive the plugs and wedges in too far or else they will retard the flow of the fluids in the pipe. Once the plugs and wedges are in place, trim them off flush with the outside surface of the pipe. Cover the damaged area with a piece of rubber that will completely cover and extend about 2 inches past the damaged area on all sides. Use two tightly wound layers of marlin or wire to hold the rubber in place.

The soft patch can be modified or improved to suit the conditions at hand. Often it is advisable to use a curved piece of lightweight sheet metal between the rubber and the marline or wire. A coat of red lead on the face of the rubber will also help. You can also use marlin and oakum as a caulking material in the cracks. The soft patch


THE LEAK
DRIVE IN SOFT WOOD PLUGS COVERED WITH CLOTH
2
CUT OFF PLUGS FLUSH WITH PIPE. DO NOT SET THE PLUGS TOO FAR INTO PIPE.
3
WRAP WITH SHEET PACKING BACKED BY LIGHT SHEET METAL.OVERLAP ENDS OF CRACK 2"
4
BIND WITH MARLIN OR WIRE.
5

8.508

Figure 7-23.—Soft patch on a low-pressure pipe line.

can withstand 150 psi. For some types of damage, such as sharp bends in the piping, a soft patch will not be effective. In such cases, you would use a metallic pipe patch instead of the soft patch or jubilee pipe patch.

METALLIC PIPE PATCH

The metallic pipe and general-purpose damage control kit is used to make metallic pipe patches, also referred to as a plastic patch. The kit is part of the required repair locker equipment inventory and contains the materials needed to repair various piping-system lines. Most of these repairs can be made and the system restored to service within 60 minutes.

Kit Contents

The complete kit contains the materials listed below. These materials may be ordered individually whenever a need arises to replace them in the kit.

Assembly I

- Four cans liquid resin, 400 grams each
- Four cans liquid hardener, 100 grams each
- One piece woven roving cloth, 24 by 40 inches
- One piece void cover, 8 by 36 inches
- One piece polyvinyl chloride (PVC) film, 48 by 60 inches
- One chalk line, one-eighth of a pound
- Four pairs of gloves
- Two eyeshields
- Four wooden spatulas
- One sheet of abrasive cloth, 9 by 11 inches
- One pair of scissors
- One instruction manual

Assembly II

- Four cans paste resin, 300 grams each
- Four cans paste hardener, 75 grams each
- Four tongue depressors

Before you can have a good understanding of the kit and its uses, you will need to know more about plastics in general. The following paragraphs will give you the basics on the materials in the kit.

RESINS AND HARDENERS.—The liquid and paste resins are of the epoxy type. The liquid and paste hardeners are chemical compounds used to harden the resins. These resins and hardeners are packaged in premeasured amounts. For proper mixture and better results, mix all of the hardener in the smaller can with all of the resin in the larger can.

CAUTION: DO NOT MIX HARDENER WITH RESIN UNTIL ALL PREPARATIONS HAVE BEEN COMPLETED. DO NOT INTERMIX LIQUID RESIN AND PASTE HARDENER OR PASTE RESIN AND LIQUID HARDENER.

When the resins and the hardeners are mixed together, a chemical reaction begins. This reaction is exothermic, which means that heat is given off. For approximately 12 to 17 minutes, the temperature increases gradually until it reaches 120 °F to 135 °F. At this temperature a sudden, sharp increase in the temperature occurs until it reaches its peak at about 350 °F. This sudden, sharp rise in temperature is known as *kick-over*. At this peak temperature, the resin-hardener mixture begins to solidify and change color from gray to light brown.

The mixture cools slowly because of the poor thermal conductivity of the materials. After kick-over, the mixture continues to harden and increase in strength. This process is known as *curing*. Approximately 30 minutes after kick-over, the patch is strong, hard, and cool enough to use. Do not restore pressure to the system until the patch has cured or when you can place your bare hand on it without discomfort from heat.

Several factors contribute to the control of kick-over. The most important is temperature. Both the initial temperature of the activated resin mixture and the temperature of the atmosphere affect the kick-over time. The initial temperature has the greater effect. When the temperature of the resin and the hardener before mixing is increased, the kick-over time decreases. Also, when those temperatures are decreased the kick-over time increases.

You should be able to predict the time of kick-over. The kick-over time can be controlled only within certain limits. Therefore, the patch needs to be completely applied before kick-over occurs.

Figure 7-24 shows the relationship of kick-over time to the resin temperature. If you know the resin temperature at the time of mixing, you can determine the amount of time available to apply the patch before kick-over occurs. Look at point *A* in figure 7-24 where the resin temperature is 80°. The kick-over will occur in less time than if the resin temperature was 60° (point *B*). The difference in resin temperatures means that you have 9 minutes versus 18 minutes to apply your patch.

NOTE: If the initial resin temperature exceeds 80 °F, the temperature before mixing should be reduced by artificial means to 73 °F. This allows for additional working time.

VOID COVERS.—The void cover is a resin-treated glass cloth that can be cut and formed to cover the damaged area and is rigid enough to give support to the patch.

WOVEN ROVING CLOTH.—The woven roving cloth is made of a short staple glass fiber woven into a thick, fluffy cloth. This cloth will be coated with the resin-hardener mixture and either wrapped around or placed over the damaged area. The glass cloth provides the main strength of the patch and a means of applying the resin-hardener mixture.

FILM (PVC).—The plastic film is a thin, transparent polyvinyl chloride material (PVC). It is used as a separating film for the flat patch. Its purpose is to prevent the patch from sticking to the backup plate or other supports. In the pipe patch, it is used to cover the entire patch and keep the activated resin around the patch. Kraft wrapping paper may be used as a substitute if necessary.

Advantages of the Plastic Patch

From the damage control viewpoint, the main advantages of a plastic patch are versatility, simplicity, effectiveness, speed of application, and durability.

The plastic patch can be used on a variety of damaged surfaces with smooth or jagged protruding edges. The plastic has excellent adhesive qualities. It can be readily applied to steel, cast iron, copper, copper-nickel, brass, bronze, and galvanized metals.

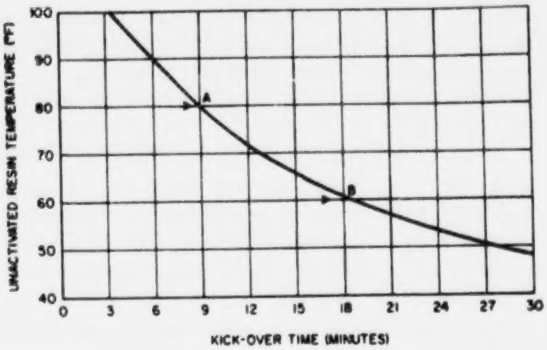


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Figure 7-24.—Resin temperature vs. the kick-over time.

It is relatively easy to apply a plastic patch. Inexperienced people can do it. If they follow instructions carefully, the patch will be 100-percent effective. If the patch leaks, then it is likely that proper preparation and applications procedures were not followed.

The speed of application will vary somewhat with the size and the type of rupture and also with local working conditions. A simple patch can be applied to a 4-inch pipe in 10 minutes or less by an inexperienced crew with the minimum amount of training and indoctrination. The type and the size of the rupture, or the shape and the size of the structure to which the patch is applied, have little effect on the time involved in patching. However, some types of damage may require more initial preparation.

There is no known time limit on the life of a plastic patch. It will certainly last until permanent repairs can be made. The patch is relatively inert, being seriously affected only by excessive heat and concentrated acids.

Application of Plastic Patches

The following discussion will help you apply different types of plastic patches (simple, elbow, severed, and others). You will see that as the individual patch materials are applied, the patch becomes progressively wider. Figure 7-25 illustrates the positions of the patch materials in relation to one another. You must consider the buildup in the length of the patch when you plan the application. When possible, allow the patch to extend at least 4 to 5 inches on either side of the rupture.

In addition to the size of the rupture, the width of the patch may also depend upon the location of the rupture in the pipe system. For example, an elbow rupture may require a patch of greater width than would the same size rupture in a straight section of pipe.

You must make the following preparations before you apply the plastic patch:

1. Secure or isolate the ruptured area in the piping system.
2. Remove all lagging.
3. Clean the area around the rupture and remove all grease, oil, dirt, paint, and other foreign matter. If grease or oil is present, use an approved solvent, such as methyl chloroform. If an approved solvent is not available, scrape and wipe the surface until it is clean. The surface may then be further abraded for better adhesion. An abrasive cloth is furnished with the kit.
4. Make sure that the entire pipe surface is dry.
5. Where practical, simplify the rupture by bending or removing irregular projections. This may be done by cutting or burning.

CAUTION: IT IS OF THE UTMOST IMPORTANCE THAT NO EXPLOSIVE CONDITIONS EXIST BEFORE USING SPARK-PRODUCING TOOLS OR BURNING EQUIPMENT.

6. Determine the amount of materials you will need. For example, a 2-inch rupture in a 2-inch-diameter pipe will require 500 grams of activated resin and a length of woven roving cloth that is at least 25 inches long. Cut the woven roving cloth, in width, to extend at least 3 to 4 inches on either side of the rupture.

SIMPLE PIPE PATCH.—Use these step-by-step procedures to apply the simple pipe patch.

1. Put on the eyeshields and the gloves. Then open the liquid resin can and the liquid hardener can.

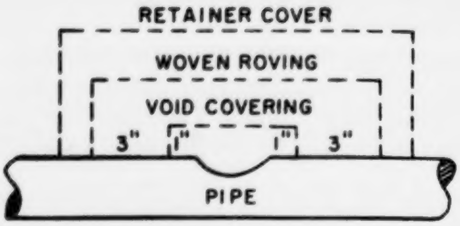


Figure 7-25.—Relative positions of patch materials.

2. Add the hardener to the resin and mix thoroughly for approximately 2 minutes or until it is a uniform gray color. (Note that all of the liquid hardener in the smaller can is the correct proportion to mix with all of the liquid resin in the larger can.)

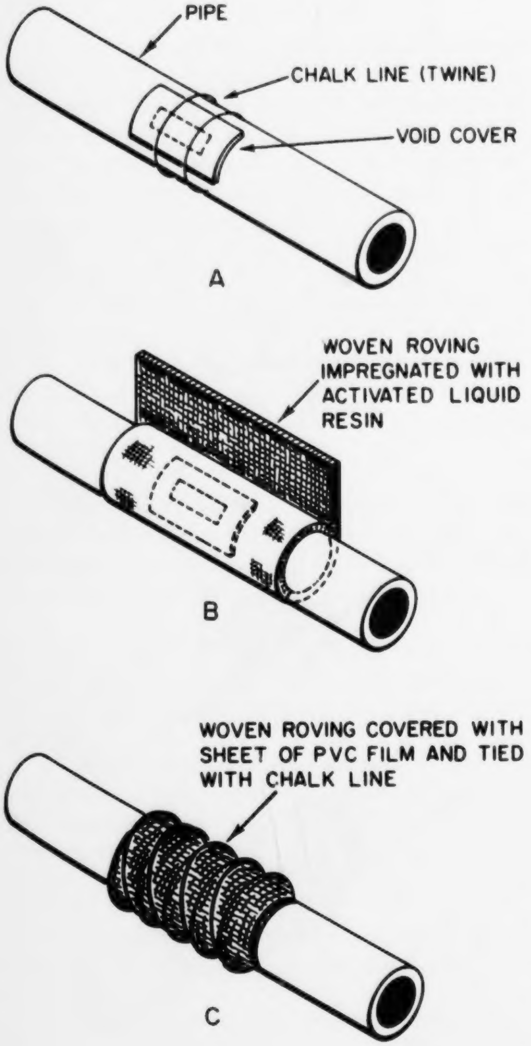
3. Coat both sides of the void cover with the resin-hardener mixture. Tie the void cover over the rupture with a chalk line (view A of fig. 7-26.).

4. Lay the woven roving cloth on a clean, flat surface. Starting at one end of the cloth, pour on the resin-hardener mixture and spread it evenly over the entire surface of the cloth using the spatula provided in the kit. It is only necessary to impregnate one side of the woven roving cloth. However, you must ensure that the edges are well impregnated with the resin-hardener mixture.

5. Center the woven roving cloth over the void cover with the impregnated side toward the pipe. Wrap the cloth around the pipe not less than three turns and preferably not more than four turns. (See view B of fig. 7-26.)

6. Wrap the PVC film at least two complete turns around the entire patch. Tie the PVC film with the chalk line, starting from the center of the patch and working toward one end, making 1/2-inch spacings between spirals (view C of fig. 7-26). Tie this end securely, but do not sever the line. Make one spiral back to the center of the patch. Then working to the opposite end from the center of the patch, make 1/2-inch spacings between spirals and again secure the line. After 30 to 40 minutes the patch should be sufficiently cured to restore the pipe to service.

Remember, for best results the temperature of the liquid resin and the liquid hardener before mixing should be approximately 70°F. With a temperature of 70°F at the time of mixing, the patch will cure approximately 1 hour from the initial mixing time. After this hour, pressure may be restored to the piping system. In emergencies, if the temperature of the resins and hardeners is below 50°F, you can accelerate kick-over by applying external heat with hot-air heaters. However, the heat must be applied gradually. Too much heat will cause the plastic patch to be extremely porous and fail.


PIPE
CHALK LINE (TWINE)
VOID COVER
A
WOVEN ROVING IMPREGNATED WITH ACTIVATED LIQUID RESIN
B
WOVEN ROVING COVERED WITH SHEET OF PVC FILM AND TIED WITH CHALK LINE
C

103.43

Figure 7-26.—Simple pipe patch.

ELBOW PATCH.—The elbow patch shown in figure 7-27 is applied using the same basic procedures as the simple patch but with the following exceptions:

1. Slit the edges of the void cover 2 to 3 inches at each end to conform to the contour of the pipe. (See view B of fig. 7-27.)

2. After the impregnated woven roving cloth has been wrapped around the pipe, use your gloved hand to shape the cloth to the contour of the pipe. (See view C of fig. 7-27.)

3. Apply the PVC film and tie it with the chalk line as described for the simple pipe patch. (See view D of fig. 7-27.)

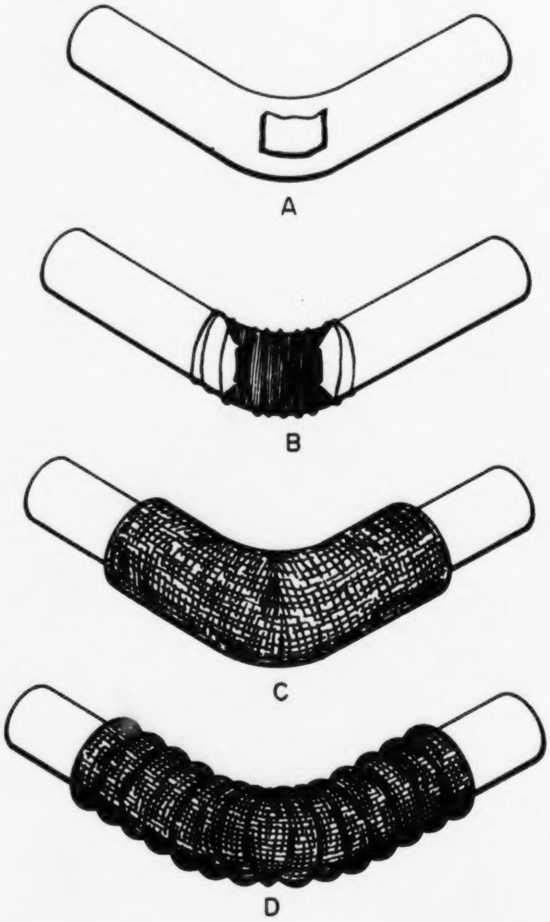


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Figure 7-27.—Elbow pipe patch.

SEVERED PIPE PATCH.—The severed pipe patch shown in figure 7-28 is also applied with the same basic procedures as the simple pipe patch. But this procedure also has some exceptions:

1. Where the gap exceeds 4 inches, thin sheet metal or other suitable materials may be used as a substitute for the void cover in bridging the gap. The substitute material should be cut so that it will extend at least 2 inches on either side of the gap. It should be long enough to provide one complete turn around the pipe with a possible overlap of about 2 inches. Secure the substitute material with the chalk line.
2. Cut the woven roving cloth so it will extend at least 4 inches beyond the edges of the bridge material. Impregnate the cloth with the resin-hardener mixture. Wrap the cloth around the bridge materials and tie it securely as you did for the simple pipe patch.
3. Apply the PVC film and tie it securely with the chalk line as you did for the simple pipe patch.

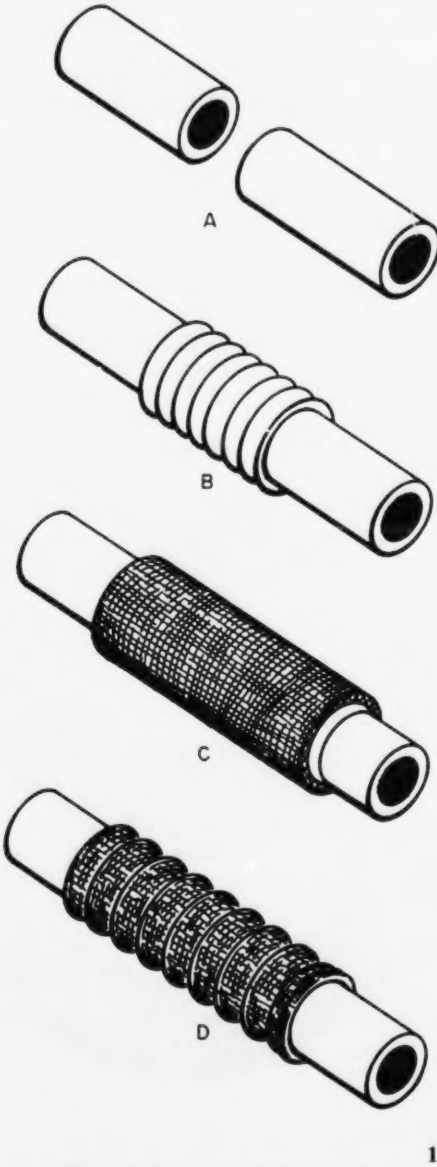

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Figure 7-28.—Severed pipe patch.

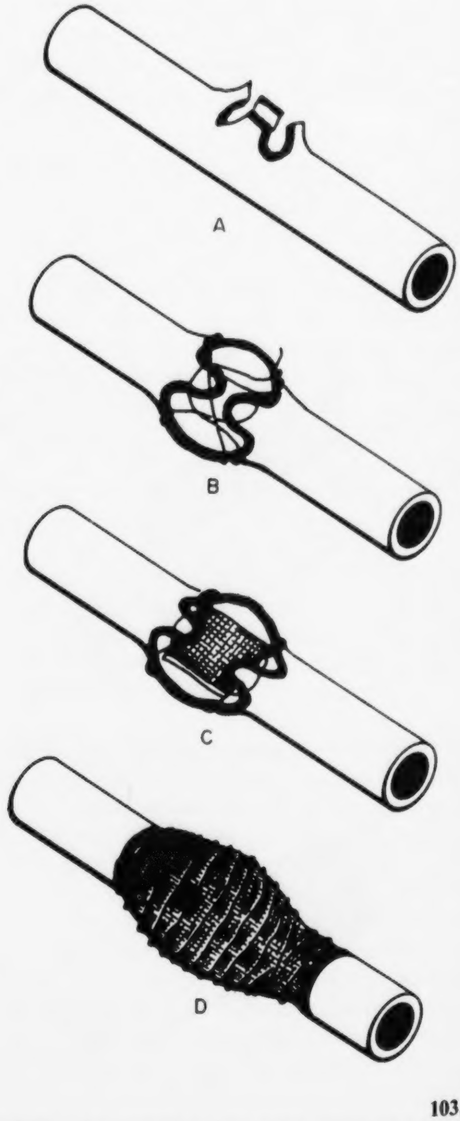

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Figure 7-29.—Compound rupture patch, edges not removed.

COMPOUND PATCH.—When repairing battle damage to piping systems, you will often work on a compound rupture, as shown in view A of figure 7-29. Compound ruptures may take a variety of shapes. Therefore, it is more difficult to select a single example to fit all repairs. In most compound ruptures, it should be possible to simplify the rupture by removing butterfly edges. You may also cut away the damaged section to form either a severed pipe or a simple pipe repair. Sometimes you cannot remove the butterfly edges or other projections by pounding them in or by cutting or burning them off. In that case, you can apply a simple pipe patch with the following modifications:

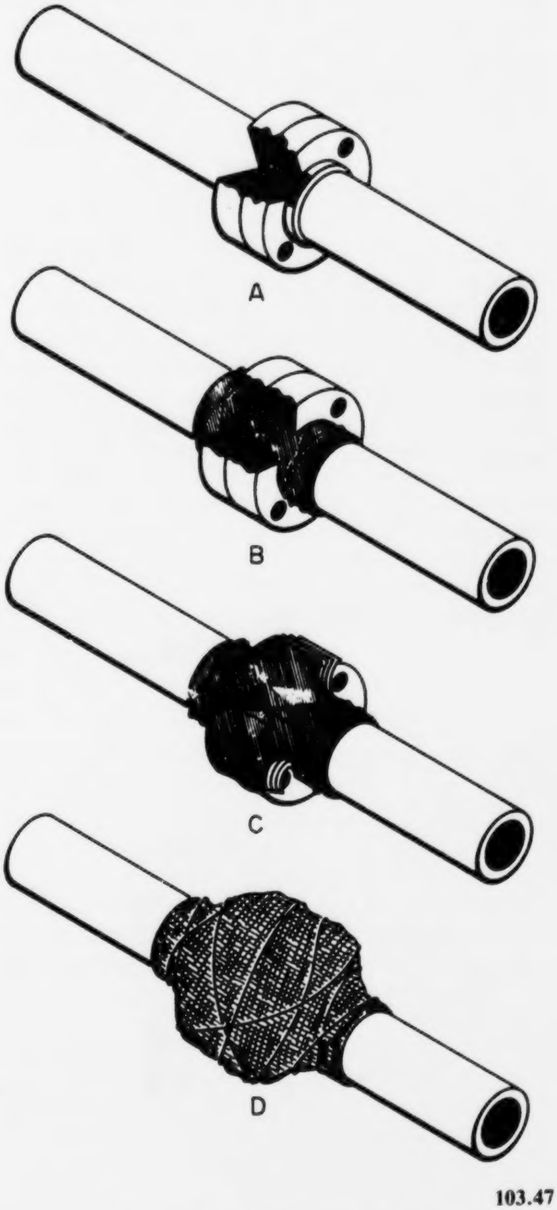
1. Tie the chalk line firmly between the jagged edges (view B of fig. 7-29), crisscrossing as much as possible. This chalk line acts as a support for the woven roving cloth and keeps it from falling into the void. No void cover is used in this example. It would be impractical to cut a void cover to suit the jagged edges.
2. Fold a small piece of impregnated woven roving cloth (view C of fig. 7-29); lay it in the void where it helps to build up the mass and acts as an insulator.
3. Apply the precut woven cloth (view D of fig. 7-29) over the small folded piece of woven cloth. Tie it firmly in place as outlined previously for the simple pipe patch.

FLANGE PATCH.—The flange patch is applied to a damaged flange (view A of fig. 7-30). The application is similar to that used for a single patch with the following modifications:

1. Cut the void cover into an H shape (view B of fig. 7-30), impregnate it with the resin-hardener mixture, insert it into the void, and tie it securely in place.
2. Cut your pieces of woven roving cloth, each of them long enough to make one complete turn around the pipe and overlap 1 inch. Cut these four pieces in an H shape, but do not cut away the center pieces. Instead, fold them up over the edges of the flange.
3. Impregnate the separate plies of woven roving cloth and place them over the rupture (view C of fig. 7-30).
4. Apply the PVC film and tie it down firmly, starting at one end working up to the flange. Make several windings of the chalk line through the gap in the flange in a figure X to have the woven roving cloth conform to the center of the rupture and the flange edges. Continue on to the opposite end of the patch and tie securely in place.

Repair Kit Review

An ideal plastic patch is one which can be applied and cured in the shortest time possible and will maintain the desired tightness. The primary factor controlling the kick-over time is the



103.47

Figure 7-30.—Flange rupture patch.

temperature of the resin and hardener before mixing. For the patch to cure in the shortest time possible, you must contain the heat generated in the patch. You do this by creating a mass about the break in the pipe or bulkhead rupture by using an impregnated woven roving cloth. You can see, therefore, that the correct amount of mass is necessary to have an effective patch. It is also important that the patch cools readily; you cannot restore pressure to the system until the patch cools to about 150 °F. The net result is that you build up a mass about the rupture that will give you a patch with the most desirable characteristics in the shortest possible time. The plastic pipe patch can withstand 300 psi at 200 °F.

CASUALTY POWER SYSTEMS

The casualty power system is one of the most important shipboard damage control systems. The system is a simple electrical distribution system. It is used to maintain a source of electrical power for the most vital machinery and equipment needed to keep the ship afloat or to get the ship out of a danger area. The casualty power system is intended to provide power during real emergencies only. It must NOT be used as a means of making temporary routine repairs.

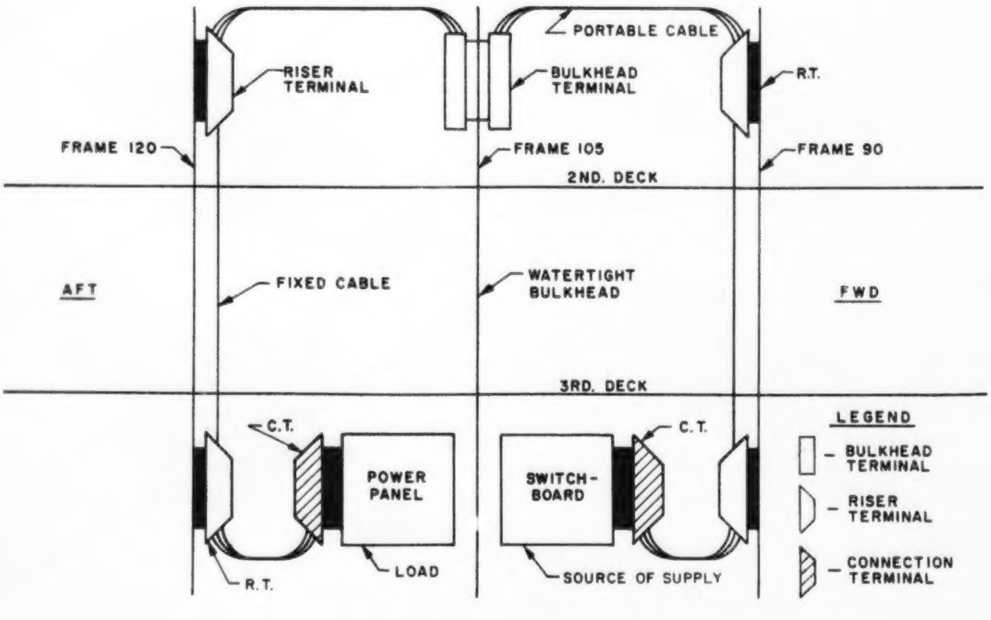
A casualty power system consists of the following items:

- Portable cables stowed in racks throughout the ship
- Bulkhead terminals for carrying the circuit through bulkheads without breaking the watertight integrity of the ship
- Risers between decks
- Casualty power connections at the source of supply

Figure 7-31 illustrates a casualty power run.

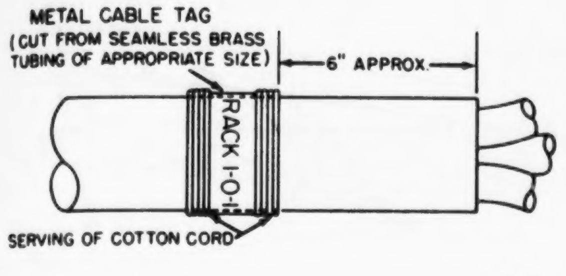
Portable casualty power cables are equipped with metal tags that indicate the length of the cable and the location of the cable stowage rack (fig. 7-32). Portable casualty power cables should be rigged only when required for use or when required for practice in rigging the casualty power system. At all other times, the cables should be stowed in the cable rack indicated on the cable tag.

When casualty power cables are rigged, the connections must always be made from the load


PORTABLE CABLE
RISER TERMINAL
BULKHEAD TERMINAL
R.T.
FRAME 120
FRAME 105
FRAME 90
2ND. DECK
AFT
FIXED CABLE
WATERTIGHT BULKHEAD
FWD
3RD. DECK
C.T.
POWER PANEL
SWITCH-BOARD
C.T.
LEGEND
- BULKHEAD TERMINAL
- RISER TERMINAL
- CONNECTION TERMINAL
R.T.
LOAD
SOURCE OF SUPPLY

103.140

Figure 7-31.—Casualty power run.


METAL CABLE TAG
(CUT FROM SEAMLESS BRASS TUBING OF APPROPRIATE SIZE)
6" APPROX.
RACK 1-0-1
SERVING OF COTTON CORD

12.74

Figure 7-32.—Portable casualty power cable tag.

to the supply to avoid handling energized cables. Portable signs saying DANGER—HIGH VOLTAGE must be posted at each connection and at 10-foot intervals along the length of the cable. The cables must be secured to the overhead, clear of the deck.

Sources of supply for casualty power use are provided at each ship's service and emergency switchboard. These consist of casualty power connection terminals on each switchboard; the terminals are connected to the bus bars through circuit breakers. Some ships also have small diesel-driven generators designated for casualty power use only. These generators are quite small and have very little control equipment.

Casualty power connection terminals are installed in power panels that feed equipment designed to receive casualty power. The casualty power connection terminals on the power panels may also be used as a source of supply to the casualty power system.

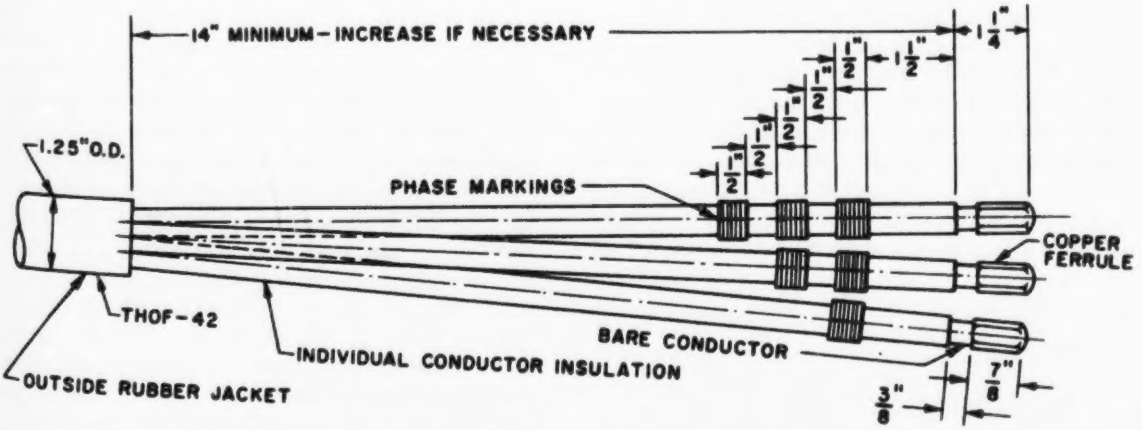
Remember that all terminals on power panels are *hot*. The normal supply to a panel must be shut off before the casualty power cable is connected to the terminals.

Machinery that can be supplied by the casualty power system includes steering gear, IC switchboards, fire pumps, and vital auxiliaries in firerooms and engine rooms.

An alternating current (a.c.) casualty power system consists of the following equipment and fixtures:

- Racks containing various lengths of portable thermoplastic-covered or neoprene-covered cable. Each cable contains three leads or conductors (fig. 7-33). One lead is colored black, one is white, and one is red. This same color code is used in all three-wire power circuits throughout the electrical installations aboard ship.

- On small ships, bulkhead terminals provide for a single horizontal run of portable cable along the main deck, inside the superstructure. On large ships, there are generally terminals for two horizontal runs, one port and one starboard. These runs are located on the second deck. The terminals extend through the bulkhead and project from it on both sides. They do not impair the watertight integrity of the ship. The cable ends are inserted around the outer rim (or curved surface) of the terminal into the holes provided. There are three groups of three holes each. The


14" MINIMUM—INCREASE IF NECESSARY
1 1/4"
1/2"
1 1/2"
1/2"
1/2"
1/2"
1/2"
1.25" O.D.
PHASE MARKINGS
COPPER FERRULE
THOF-42
BARE CONDUCTOR
INDIVIDUAL CONDUCTOR INSULATION
OUTSIDE RUBBER JACKET
3/8"
7/8"

70.6

Figure 7-33.—Portable casualty power, 450 volts, three-phase cable end.

face of the terminal also contains three groups of three holes each. The square-shanked insulated wrenches fit into these holes and are used to secure the cable in the terminal. Two of these wrenches are provided in a rack mounted on the bulkhead at each point where they are required. They must be kept in the rack at all times except when they are actually in use.

- Riser terminals are similar to bulkhead terminals. However, they are connected to other riser terminals by permanently installed armored cable to provide vertical runs. These riser terminals carry the casualty power from the generators to the main and the second deck levels.

- Portable switches are sometimes mounted on bulkheads near the cable racks. These are simply ON-OFF switches that are equipped with special holes for use with the portable cables.

The faces of the casualty power terminals of an a.c. system are marked A, B, and C, and the ends of the cables are colored black, white, and red, respectively. When connecting the cables to the terminals, connect the black lead to A, the white lead to B, and the red lead to C.

The color code is not sufficient for making proper connections in the dark or under other adverse conditions. Therefore, it is necessary to provide some means to identify each lead and its proper hole in the terminal by touch. This is accomplished by molded knobs in the A, B, and C portions of the terminals. There are one, two, or three knobs, respectively, in the A, B, and C portions of the terminals. Similarly, a piece of heavy twine is placed on the black lead of the portable cables, two pieces are placed on the white lead, and three pieces are placed on the red lead. Each of these servings of twine is about one-half of an inch wide. (A new method of phase identification is similar to the old method, except that O rings and heat shrinkable tubing have been substituted for the cotton cord servings, as shown in figure 7-34.) Each lead and its corresponding position in the terminal can be identified by merely feeling the leads and matching the number of pieces of twine on each lead with the same number of raised knobs in the proper area of the terminal. In older ships, the casualty power fittings have identifying V-shaped notches in the outer edge of the fittings instead of the knobs.

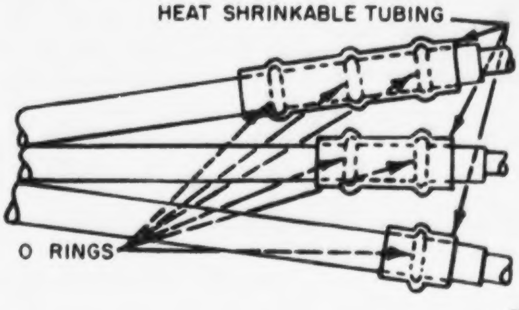


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Figure 7-34.—New method of cable identification.

When connecting a casualty power cable run, remember that you must ALWAYS connect from the load to the source of supply. This is to avoid working with live cables.

SUMMARY

When battle damage occurs, it must be repaired. In most cases, you will make a temporary repair until a permanent repair can be made. Shoring, plugging, and patching are your normal means of making the necessary temporary repairs. When the power source for certain vital equipment is discontinued, you will be required to supply power to the equipment by an alternate means, known as the casualty power system.

Review the information presented to you in this chapter until you are familiar with it. If it is possible, put the information into practical use with training aids such as a section of pipe that may be connected to a ship's fireplug. Do not use expendable materials for training purposes until you have received permission from your work center supervisor or the damage control assistant (DCA).

CHAPTER 8

RADIOLOGICAL EFFECTS AND COUNTERMEASURES

As a Damage Controlman, you will be assigned to a repair party during general quarters. There you will take part in CBR countermeasures to limit the effects of a CBR attack. To help you carry out your duties, you should know the types of nuclear bursts and their effects. You will need to evaluate the amount of contamination caused by the nuclear burst and how much radiation you absorbed. Therefore, you will need to know how to operate and read the various personnel dosimeters and radiac monitoring instruments aboard ship. In addition, you will need to know your duties on a monitoring and survey party. We will discuss these items and the protection that various materials will give you against a nuclear burst.

For more basic information on CBR defense, consult the appropriate references listed in the *Bibliography for Advancement Study*, NAVEDTRA 10052. For more comprehensive and detailed information, consult chapters 70 and 470 of the *Naval Ships' Technical Manual* and COMNAVSURFLANTINST 3542.1B, the *Repair Party Manual*.

THE ATOM

There are about 100 different simple materials known as elements. They make up every substance around us. Among the common elements are the gases, such as hydrogen, oxygen, and nitrogen; the solid nonmetals, such as carbon, sulfur, and phosphorous; and the metals, such as iron, copper and zinc. The element uranium is normally a solid metal and is used for nuclear energy.

The smallest quantity of any element that retains the characteristics of that element is the atom. Atoms are made up of even smaller particles known as electrons, protons, and neutrons. The characteristics of an element are determined by the relative numbers of these smaller particles.

The electron is extremely tiny. Its size is only about 1/1840 the mass of a proton. The electron has a negative electrical charge. The proton has a positive electrical charge. A neutron is composed of a proton and an electron. The neutron has no charge because the equal and opposite charges of the electron and the proton cancel each other.

The structure of an atom resembles a solar system, with the electrons orbiting around the protons and the neutrons clustered tightly in the center, called the nucleus (fig. 8-1). Because the distance between the electrons and the nucleus is so great, the atom is mostly empty space. The number of electrons that orbit the nucleus of a normal atom is equal to the number of protons in the nucleus. Therefore, the electrical charge of the atom is balanced. The number of neutrons in a nucleus can vary from 0 to more than 150.

A process known as fission splits the nucleus of a heavy element into nuclei of lighter elements. In this process, an enormous amount of energy is produced. When this energy is released in a short

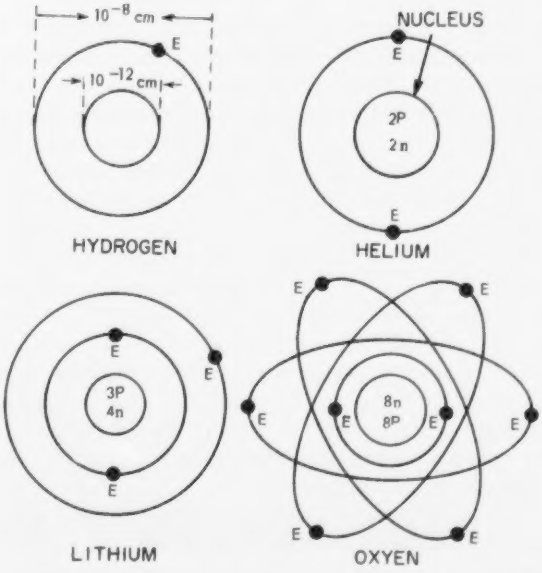

Figure 8-1.—Rutherford-Bohr atomic models.

period of time, an enormous explosion takes place. This explosion is what we call a nuclear burst.

NUCLEAR BURSTS

When a nuclear device is detonated in space, in the atmosphere, or at or below the surface of the earth or ocean, many characteristic effects are produced. Some effects, such as nuclear radiations and expanding debris, are common to all of these environments, though varying in degree. Other effects, such as cratering, blast, and water shock, are peculiar to certain environments. Effects such as light and heat are visible or tangible. Others, like nuclear radiations, are not directly apparent and can only be discerned by instruments or secondary effects. Some effects occur in and last only microseconds, whereas others occur in microseconds but linger for days, months, or even years. Meteorological conditions such as atmospheric pressure, temperature, humidity, winds, and precipitation can affect some of the observed phenomena. All nuclear detonations, however, produce effects that can damage equipment and injure personnel.

The energy released from a nuclear detonation below an altitude of approximately 100,000 feet may be divided into three broad categories. Approximately 50 percent of the energy will be used to produce blast and shock, about 35 percent to produce thermal radiation, and about 15 percent to produce nuclear radiation. The nuclear radiation consists of about 10 percent residual nuclear radiation and about 5 percent initial nuclear radiation. Initial radiation is delivered simultaneously with the detonation and cannot be avoided by maneuvering or evasive actions. The initial radiation dose received will occur within 1 minute after the explosion, and most of it will occur within a matter of seconds. Residual radiation, on the other hand, may be emitted over a long period of time, extending to days and years. Therefore, maneuvering out of an area contaminated by residual radiation may be an effective countermeasure.

When the detonation occurs beneath the surface of the earth or water, some of the energy released is captured beneath the surface. For example, little or no thermal or initial radiation energy from an underwater or underground burst can escape to the surface.

The militarily significant effects of nuclear weapons are covered in the following paragraphs to provide a general understanding of each effect. However, you should refer to other publications for complete information.

The energy yield of a nuclear weapon is described in terms of the amount of TNT that would be required to release a similar amount of energy. Thus, a nuclear weapon capable of releasing an amount of energy equal to the energy released by 20,000 tons of TNT is said to be a 20-kiloton (20-kt) weapon. A nuclear weapon capable of releasing an amount of energy equal to the energy released by 1 million tons of TNT is said to be a 1-megaton (1-Mt) weapon.

A weapon's yield may be a fraction of a kiloton or up to several megatons. Although a weapon's total yield is not significantly influenced by the environment about the burst point, the relative effect of the weapon depends a great deal on the location of the detonation. The detonation can be classified as one of the following, according to its location:

- Airburst
- High-altitude burst
- Surface burst
- Underwater burst
- Underground burst

Often the underwater and the underground bursts are referred to as subsurface bursts. A discussion of each of the five types of bursts and their effects follows.

AIRBURST

An airburst (fig. 8-2) is a burst where the point of detonation is below an altitude of 100,000 feet and the fireball does not touch the surface of the earth. Air blast, thermal radiation (heat and light),

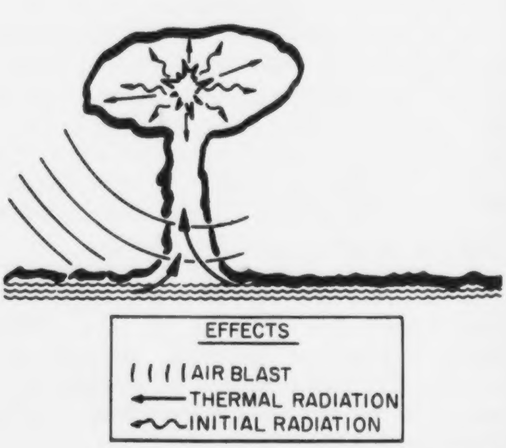

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Figure 8-2.—Airburst.

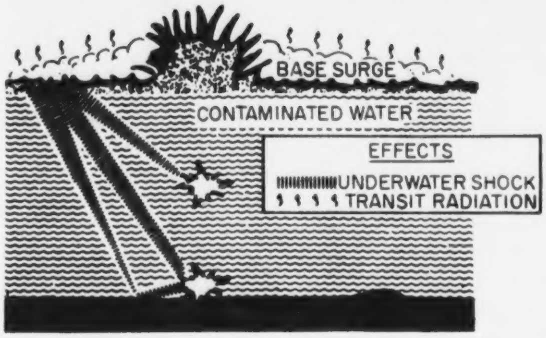
an electromagnetic pulse, and initial nuclear radiation (neutron and gamma rays) are produced around the point of detonation. There will be no significant residual nuclear radiation (gamma and beta radiations from airborne or deposited radioactive material) unless rain or snow falls through the radioactive cloud. The types and effects of radiation will be discussed later in this chapter.

HIGH-ALTITUDE BURST

A high-altitude burst is an airburst where the point of detonation is above 100,000 feet. The high-altitude burst produces air blast, thermal radiation, an electromagnetic pulse, initial nuclear radiation, and atmospheric ionization. At such high altitudes, the proportion of energy appearing as blast decreases considerably, and at the same time the proportion of radiation energy increases. Due to the low density of the atmosphere above 100,000 feet, the range of the initial nuclear radiation increases. In contrast to explosions below 50,000 feet, the attendant atmospheric ionization from a burst above 100,000 feet will last from minutes to hours. The important effects of high-altitude bursts cause damage to weapons systems or satellites operating in the upper atmosphere or in space. There will also be interference with electromagnetic waves (communications and radar) that pass through or near the region of the burst.

SURFACE BURST

A surface burst (fig. 8-3) is a burst where the point of detonation is on, or above, the surface of the earth and the fireball touches the surface of the earth. The surface burst produces air blast, thermal radiation, and an electromagnetic pulse. It procudes initial nuclear radition around surface zero (SZ), and residual (transit and deposit) nuclear radiations around SZ and downwind from SZ. Transit radiation is airborne radioactive material (base surge/fallout). Deposit radiation is radioactive material (base surge/fallout) that settles on exposed surfaces. Surface bursts over water will also produce underwater shock and surface water waves, but these effects will be of less importance except to submarines. Overland, earth shock will be produced but will not be an important effect at any significant distance from the point of detonation.

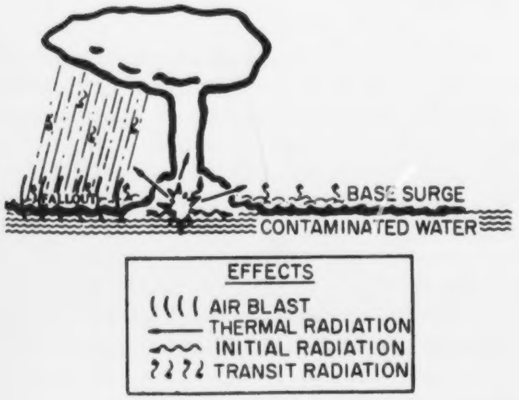

BASE SURGE
CONTAMINATED WATER
EFFECTS
UNDERWATER SHOCK
TRANSIT RADIATION

188.37

Figure 8-4.—Deep underwater burst.

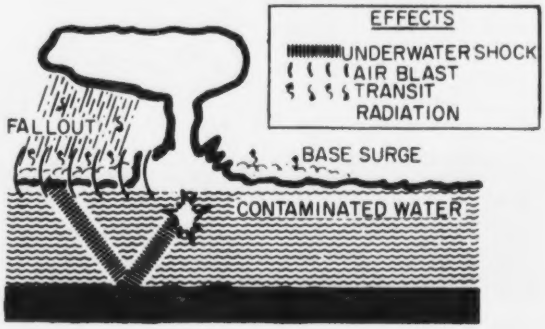
UNDERWATER BURST

An underwater burst (figs. 8-4 and 8-5) is a burst where the point of detonation is below the surface of the water. An underwater burst produces underwater shock and a water plume


FALLOUT
BASE SURGE
CONTAMINATED WATER
EFFECTS
AIR BLAST
THERMAL RADIATION
INITIAL RADIATION
TRANSIT RADIATION

5.47

Figure 8-3.—Surface burst.


EFFECTS
UNDERWATER SHOCK
AIR BLAST
TRANSIT RADIATION
FALLOUT
BASE SURGE
CONTAMINATED WATER

103.159

Figure 8-5.—Deep underwater burst.

which then causes a base surge. Bursts with very shallow points of detonation can also produce air blast, initial nuclear radiation, fallout, and possibly some thermal radiation. These effects will be reduced in magnitude from those of a water surface burst and will become rapidly insignificant as the depth of the point of detonation is increased. The range of damage due to shock is increased as the depth of the point of detonation is increased. For a given weapon yield, greater hull and machinery damage will be produced by shock from an underwater burst than by air blast from an airburst or a surface burst. The reverse is true for topside equipment such as antennas and missile launchers.

When a high-yield weapon is detonated in deep water adjacent to a continental shelf, large breaking waves can be generated by the upsurge along the shelf slope. These waves will appear on the shallow-water side of the shelf edge. They are characterized by a long period with a sharp, possibly breaking, crest. They dissipate in amplitude as they progress toward the shore. Calculations and simulation experiments were conducted with the continental shelf off the east coast of the United States. They indicate that in the near vicinity of the shelf edge (shallow-water side only), these waves may be large enough to damage the largest combatant ships and to swamp or capsize smaller ships. This shoaling phenomenon does not appear in deep water. Except in shoaling waters, water waves normally will not be a major hazard.

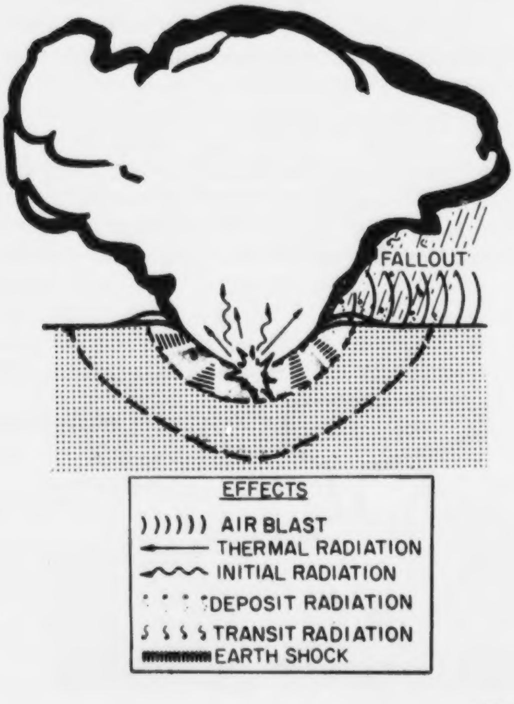


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Figure 8-6.—Underground burst.

UNDERGROUND BURST

An underground burst (fig. 8-6) is a burst where the point of detonation is below the ground's surface. An underground burst produces a severe earth shock, especially near the point of detonation. Thermal radiation, air blast, initial nuclear radiation, and fallout will be negligible or absent if the burst is confined below the earth's surface. For shallow underground bursts, the air blast, thermal radiation and initial nuclear radiation will be less than for a ground surface burst. Ground shock will cause damage within about three crater radii, but little beyond. Early fallout can be significant, and at distances near the explosion, base surge (evidenced by a dust cloud) will be an important hazard.

WEAPON EFFECTS AND THEIR MODIFICATION BY THE ENVIRONMENT

Specific effects depend on the type of nuclear weapon and the type of burst. These effects are influenced considerably by the environment in which the weapon is detonated. A description of the weapon effects and the modification caused by the environment is provided in the following paragraphs.

AIR BLAST

Air blast is the shock wave that is produced in the air by an explosion. The shock wave initially travels outward at a velocity of approximately seven times the speed of sound at high overpressures (overpressure is any pressure greater than normal atmospheric pressure). It will then gradually slow down to sonic speed (about 1,000 feet per second [ft/s]) at low overpressures. An air blast produces a rapid increase in the normal atmospheric (static) pressure and causes high wind (dynamic) overpressures. High static overpressures cause damage by squeezing and crushing targets. Dynamic overpressures cause damage by bending or dragging targets. Ship structures and buildings are primarily vulnerable to static overpressures, whereas aircraft, masts, antennas, and exposed personnel are vulnerable to dynamic overpressures.

Air blast is measured in pounds per square inch (psi) over the ambient or atmospheric pressure. The damage produced by an air blast is related to the peak static and dynamic overpressures.

UNDERWATER SHOCK

Underwater shock is the shock wave that is produced in the water by an explosion. The shock wave initially travels several times the speed of sound in the water but quickly slows down to hypersonic speed (approximately 5,000 ft/s). Underwater shock produces rapid accelerations that can disarrange equipment and machinery, rupture hulls, and/or injure personnel. Both the directly transmitted shock wave and the shock wave reflected from the sea bottom can be damaging. An underwater explosion produces a shock wave similar to that of an airburst. However, underwater shock damage is measured by the peak vertical velocity (for surfaced ships) and by the peak translational velocity (for submerged submarines) rather than by the water overpressures produced by the shock front. Figure 8-7 shows the direct and reflected shock waves.

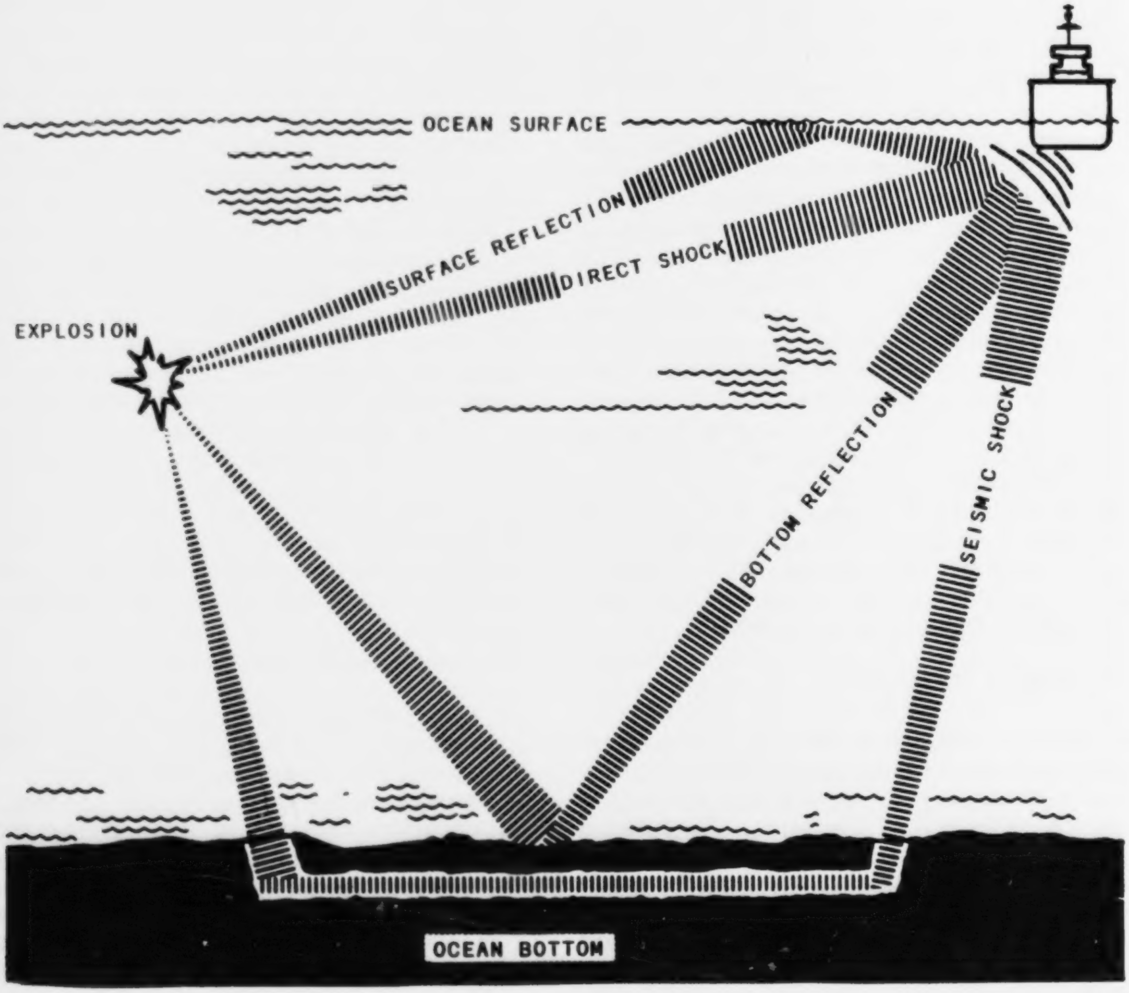

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Figure 8-7.—Direct and reflected shock waves for an underwater burst.

Four factors determine whether the greater damage will be caused by the direct wave or the reflected wave:

- Distance from burst
- Depth of burst
- Depth of water
- Bottom configuration and structure

When the point of detonation is above the bottom, the shock wave reflected from the bottom can produce more severe damage to weapon-delivery equipment at a given range than the direct shock wave. Even though the peak pressure of the reflected wave is less than that of the direct wave, the reflected wave will disperse in a more nearly vertical direction. It is, therefore, more effective in producing the vertical motions that control the degree of damage.

The time separation between direct and reflected shock waves decreases as the point of detonation approaches the bottom. When the point of detonation is directly on the bottom, the two waves overlap. For such a burst, the water depth has a direct effect on the range at which the weapon-delivery capability of surface ships will be impaired. However, the water depth has no significant effect on the ranges at which their mobility and seaworthiness will be impaired. Where the sea bottom is sloped, a ship downslope from the point of detonation will tend to receive less damage than a ship an equal distance upslope from the point of detonation. Where the sea bottom is essentially flat, the strength of a reflected wave will depend on the bottom structure. It will be less for mud than for sand, but greater for rock than for sand.

THERMAL RADIATION

Thermal radiation is the radiant energy (heat and light) that is emitted by the fireball. Thermal radiation travels at the speed of light and persists as long as the fireball is luminous. The duration of thermal radiation emission depends on weapon yield. It will last less than 1 second for a 1-kt yield and approximately 8 or 9 seconds for a 1-Mt yield. Thermal radiation is effectively shielded by anything that will cast a shadow (opaque materials). Thermal radiation can incapacitate exposed personnel by causing skin burns, flash blindness, or retinal burns.

Overland, thermal radiation will ignite fires in buildings, vehicles, dry vegetation, and other combustible materials.

Thermal radiation is modified by the height of the point of detonation, weapon yield, atmospheric conditions, cloud cover, and terrain features. As the height of the point of detonation is increased, the area of the earth's surface exposed to the thermal radiation increases because line-of-sight area increases and there are less shadows from such things as existing structures, vegetation, and terrain features.

As the weapon yield is increased, the range at which thermal radiation can cause skin burns and eye injuries to exposed personnel increases. It will extend well beyond the range at which blast and initial nuclear radiation are of significance. The emission rate of thermal radiation from a high-yield weapon is slower than that from a low-yield weapon. Thus, the high-yield weapon must deliver more thermal energy to do an equivalent amount of damage because a target has more time to dissipate the heat being received.

The ability of the atmosphere to lessen the effect of thermal radiation depends on such factors as absorption by water vapor, carbon dioxide, ozone, and impurities in the air. On days when fog, haze, and clouds are between the point of detonation and the target, thermal radiation will be decreased. On the other hand, when fog, haze, and clouds are above the burst and the target, a significant amount of thermal radiation will reflect downward and increase the severity of burns received at a given location. Such conditions can also increase the number of personnel who are flash blinded or dazzled by a burst. The terrain surface cover, such as snow, can also reflect significant thermal radiation. This adds to both the range and severity of the thermal effect.

NUCLEAR RADIATION

Four basic types of nuclear radiation are given off during a nuclear explosion: alpha particles, beta particles, gamma rays, and neutrons.

Alpha particles travel only a few centimeters in air before they are stopped. They cannot penetrate even a thin sheet of paper.

Beta particles can travel several feet in air, but they cannot penetrate a sheet of aluminum that is more than a few millimeters in thickness. Beta particles cannot penetrate the normal combat uniform.

Gamma rays are a form of electromagnetic radiation, indistinguishable from X rays.

Neutrons are electrically neutral particles. Both gamma rays and neutrons can travel great distances in air. Gamma rays and neutrons have greater penetrating power than the other forms of nuclear radiation. Their injurious effects on personnel are also quite similar.

Nuclear radiation does not affect most materials in any visible manner. Thus ships, vehicles, electronic equipment (except transistors), and other equipment are not damaged by radiation. However, radioactive contamination does pose a danger to operating personnel. The term *contamination* is used to mean radioactive material that has been deposited where it is not wanted. All radioactive contamination presents a hazard to personnel.

ATMOSPHERIC IONIZATION

Atmospheric ionization is an increase in the density of electrons in the atmosphere around a nuclear burst. These electrons affect radio and radar signals by removing energy from the waves. This decreases the strength of the signals and refracts the wave front, thereby changing the direction of transmission. For detonations below 100,000 feet, this effect disappears in a matter of seconds. At higher altitudes the effect can last up to several hours. The effect can be of considerable importance where communications are over a long range and where radar targets are in or above the ionized layer.

ELECTROMAGNETIC PULSE

An electromagnetic pulse (EMP) will be produced by high-altitude bursts, airbursts, and surface bursts. The initial nuclear ionizing radiation will ionize the atmosphere around the point of detonation. This will produce the EMP, which will contain frequency components in the range from a few to several hundred kilocycles per second. The EMP has magnetic and electric field components which exist for only a fraction of a second. The magnetic field component is significant inside the radius of the ionized atmosphere. It can induce large currents in cables and long-lead wires. These large transient currents can burn out electronic and electrical equipment. The electric field component can also produce transient signal overloads and spurious signals on communication nets and in computer-driven systems. At ranges where ships suffer minor damage from other weapon effects, the major effect of the EMP is expected to be the tripping of circuit breakers and blowing of fuses in protective circuitry. At closer ranges, there is a high probability of permanent damage to the electronic and electrical equipment.

INITIAL NUCLEAR RADIATION

Initial nuclear radiation is defined as the radiation (essentially neutrons and gamma rays) that is emitted by the fireball and the cloud during the first minute after detonation. All significant neutron radiation is emitted in less than 0.1 second, and gamma radiation up to 20 or 30 seconds, depending on weapon yield. The 1-minute limit is set, somewhat arbitrarily, as the maximum time for the nuclear cloud to rise beyond the range in air at which gamma radiation is a significant hazard. Generally, initial nuclear radiation might not produce significant material damages, but it will incapacitate personnel.

FALLOUT

Fallout is a major effect of a surface, shallow underground, or underwater burst. It is the radioactive material that falls from the nuclear cloud and is deposited on exposed surfaces. The fallout consists primarily of fission products (gamma and beta emitters) mixed with material that was vaporized by the fireball and drawn up into the nuclear cloud. Fallout, whether airborne or deposited, is a major hazard because it emits gamma radiation. This radiation can penetrate ship structures, buildings, and aircraft, to name a few. It can also reach personnel, causing radiation injury, incapacitation, and even death. Deposited fallout also presents a contamination hazard to personnel. The militarily significant fallout, often called early fallout, is usually deposited in less than 24 hours in an area downwind of SZ.

The area contaminated by fallout is determined by the wind directions up to the top of the cloud. In a complete calm, the fallout pattern is roughly circular. A constant wind direction causes an elongation of the pattern. Complicated wind patterns (wind shear) as well as variations in wind speed and direction cause complicated ground patterns. The fallout pattern is difficult to predict accurately except under calm and very stable wind conditions.

An airburst or a smaller weapon will reduce fallout. Also, the complete containment of an underground burst will eliminate fallout.

Fallout landing on water will sink and will not be a hazard to ships that pass through the area after the fallout has stopped coming down. Fallout over a land area will remain on the surface and will be a hazard to personnel living in or passing through the area. Eventually all fallout will decay to a militarily insignificant level.

BASE SURGE

Base surge from an underwater burst is a rapidly expanding cloud or mist of water droplets. This cloud is produced by the collapse of the water column which was thrown up by the underwater detonation. After the early, rapid expansion of the visible base surge (2 to 4 minutes), the base surge moves downwind at the speed of the surface wind. The base surge will become invisible in less than one-half hour. The radioactivity initially will occupy about the same volume as the visible base surge. However, as the water droplets evaporate, the radioactive particles and gases will remain in the air and continue to disperse as an invisible radioactive base surge. For approximately 30 minutes after the burst, the base surge is highly contaminated with fission products and is a source of intense transit radiation.

Airborne fallout and base surge contamination can enter a ship or shore installation through the ventilation and combustion-air systems. This could present a radiological hazard. In some instances, hazardous amounts of contamination could concentrate in ventilation ducts, boiler air passages, and interior spaces. High concentrations of radioactive material in these trunks may produce a gamma-radiation hazard to personnel working nearby. Radioactive material deposited in interior spaces may also present radiation hazard to personnel coming into contact with beta particles, even though there may be only a minor penetrating gamma-radiation hazard. For aircraft in flight, the entry of airborne radioactive materials will not be a hazard during the flight but may represent a hazard to maintenance personnel later.

RADIOACTIVE WATER POOL

A surface or underwater nuclear detonation creates a radioactive water pool in the area of the detonation. This pool expands outward rapidly from SZ, for about 2 minutes, then continues to expand more slowly. At 30 minutes, dispersion of the pool and radioactive decay will have reduced the hazard to one of tactical insignificance. During the early expansion phase of this pool, a dose rate of several thousand rad/hr may exist at the water surface.

PERSONNEL INJURIES

Injuries to personnel can be caused by the blast, by thermal radiation, and by nuclear radiation. Personnel receiving these injuries are generally described as combat ineffectives (CIs) or fatalities. A CI is defined as anyone unable to man a battle station. The potential for a given nuclear weapon to produce fatalities is fairly well known. The potential for CIs is not well known. We have no satisfactory method for estimating the extent to which combined injuries relate to the number of CIs. Therefore, for each weapon effect capable of injuring an individual, the non-injury and fatal levels are stated. Only the estimates of the degree of injury are stated for the levels between these injury categories.

Air Blast Injury

Bodily displacement is the dominant cause of air blast casualties for personnel in the open. Personnel can be picked up and thrown by the blast. They receive their injuries upon landing. The extent of the injuries will depend upon the velocity of the body's movement, the nature of the object with which the body collides, and the nature of impact, whether glancing or solid.

Primary blast effects are associated with injuries from static overpressure. Eardrums can rupture at about 5 psi, lung injuries occur at approximately 15 psi, and fatalities begin at 30 psi.

Personnel standing in the open will be picked up and thrown by gust winds at overpressures of approximately 6 psi. Personnel prone in the open will be picked up and thrown at overpressures of approximately 12 psi.

Underwater Shock Injury

Underwater shock produces injury among topside and below-deck personnel by the rapid upward movement of the deck. Table 8-1 shows the estimated peak vertical velocity, in feet per second, that will produce certain injuries from underwater shock. It should be noted that the peak vertical velocities are the same as those required to produce damage to the ship.

Table 8-1.—Combat Ineffectives from Underwater Shock

EFFECT	PEAK VERTICAL VELOCITY (ft/s)
Broken ankles or heel bones	10
Seated or supine man, collision with adjacent objects	15
Standing man, skull injuries	20

188.34

Thermal Radiation Injury

Thermal radiation can cause burn injuries directly when the skin absorbs radiant energy. It can also cause burn injuries indirectly as a result of fires started by the radiation. Direct burns are often called flash burns; they are produced by the flash of thermal radiation from the fireball. The indirect, or secondary, burns are called flame burns. These burns are like the skin burns that are caused by any large fire, no matter what its origin.

Because thermal radiation can burn the retina of the eye, it can cause permanent eye damage to personnel looking directly at the burst. For example, a 1-megaton burst 25 miles high could produce retinal burns out to the horizon on clear nights. A more frequent occurrence is the temporary loss of visual acuity (flash blindness or dazzle). This is caused by exposure to the extreme brightness of a nuclear burst, particularly at night when the eyes have adapted to the dark. This may happen regardless of the direction you are facing. Flash blindness or dazzle occurs at ranges beyond those for retinal burns. Little data on the ranges at which flash blindness will occur is available.

Nuclear-Radiation Injury

Radiological hazards described in this section are those which might be of significance for the military effectiveness of naval personnel in combat operations. Injuries to personnel can be caused by exposure to initial or residual radiation or a combination of the two. Unlike injuries from other weapon effects, nuclear ionizing radiation injuries may not become evident immediately unless a high enough dose is received. Nuclear radiation, even in very small doses, has some harmful effects on the body. It should be avoided whenever possible, without interfering with military operations.

FACTORS INFLUENCING RADIATION INJURIES.—The biological injury to an individual who has received nuclear radiation will depend on many factors. Some of these factors are discussed in the following material. (All radiation doses referred to in this book are due to external whole-body exposures to penetrating radiation.)

- Radiation dose received
- Partial or whole-body exposure
- Period over which the dose is received
- Variations in the body's resistance to radiation injury, including those due to physical condition, sex, and age
- Previous radiation exposure
- Presence or absence of other injuries
- Periods of recuperation between periods of radiological exposure

The time required for a previously unexposed individual in good health to get sick or die after exposure will vary. It depends primarily on the total dose received, the period of time over which it was received, and variations in individual physical makeup. Some individuals have greater resistance to radiation injury than others have, and some may have had partial body shielding when exposed. For those personnel, a larger dose is required to produce a given biological effect. Individuals previously exposed may require less radiation to make them combat ineffective than those who were not previously exposed. The human body can repair some of the radiation injury but not all of it. Generally, a given dose received in a short period of time will be more harmful than the same dose received over a longer period of time. For practical purposes, the types of radiation exposures are as follows:

- Acute. Those in which doses are received in a short time, normally less than 24 hours, as a result of exposure to initial radiation, base surge, or fallout, or combinations thereof.

- Protracted. Those in which doses are received over a longer period of time, normally greater than 24 hours, as a result of exposure to fallout.

Table 8-2 outlines the effects of radiological hazards associated with a variety of dose ranges for both acute (less than 24 hours) and protracted (over 24 hours) doses. Table 8-3 describes symptoms and probable effects for various exposures.

CHARACTERISTICS OF RADIATION SICKNESS.—Radiation sickness is the complex

Table 8-2.—Guide for the Acute Effects of Whole-Body-Penetrating Ionizing Radiation of Personnel (This table applies equally to initial and residual gamma radiation.)

DOSE RECEIVED IN LESS THAN 24 HOURS (rads)	EFFECT (POST-EXPOSURE)
0 - 200	Mild illness in many resembling seasickness, with some incapacitation.
200 - 350	Incapacitation in 9 - 24 hours. Some deaths.
350 - 500	Incapacitation in 5 - 24 hours. Many deaths.
500 - 1,000	Incapacitation in about 3 - 24 hours. Most die.
DOSE RECEIVED IN MORE THAN 24 HOURS TO 2 WEEKS (rads)	
0 - 200	No acute effects.
200 - 500	Incapacitation from about 1 week. Many deaths.
500 - 1,000	Incapacitation from about 4 days. Most die.

NOTES:

1. It is currently estimated that an instantaneous whole-body dose of 5,000 to 10,000 rads would lead to immediate CI.
2. These figures should only be used as a broad guide since:
   - a - Whole-body dose will only occur rarely and partial dose due to partial body shielding will be more common.
   - b - Individuals will vary in their resistance to radiation injury.
   - c - Individual will vary in their reactions to radiation.
   - d - Mechanical injury will affect the biological response to radiation injury.
   - e - Estimates of whole-body absorbed dose are likely to be only ±50% accurate.
3. For operational planning in combat situations, biological recovery is not significant during 1 or 2 weeks of protrated exposure.

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Table 8-3.—Symptoms and Probable Effects for Various Exposures to Penetrating Radiation (Based on whole-body, single, acute exposure to gamma and/or neutron radiation.)

ESTIMATED EXPOSURE RANGE (rad)	INITIAL SYMPTOMS	ONSET OF SYMPTOMS	INCAPACITATION	HOSPITAL COURSE	DURATION OF HOSPITALIZATION	FINAL DISPOSITION
50-200	None-to-transient, mild headache.	Approximately 6 hours after exposure, if they occur.	None-to-slight decrease in ability to conduct normal duties.	Hospitalization required for less than 5% in upper part of exposure range.	45-60 days in upper part of range.	Duty. No deaths anticipated.
200-500	Headache, nausea, and vomiting; malaise. Symptoms not relieved by antiemetics in upper part of exposure range.	Approximately 4-6 hours after exposure.	Can perform routine tasks. Sustained combat or comparable activities hampered for period of 6 to 20 hours.	Hospitalization required for 90% of exposed personnel in this range. Hospitalization follows latent period of 17-21 days duration.	60-90 days.	Some deaths anticipated; probably less than 5% in lower part of range, increasing toward upper range.
500-1,000	Nausea and vomiting prolonged, intractable, and severe. Diarrhea and fever early in upper part of exposure range.	Approximately 1-4 hours after exposure.	Can perform only simple routine tasks. Significant incapacitation in upper part of exposure range. Lasts more than 24 hours.	Hospitalization required for 100% of exposed personnel. Latent period short, 7-10 days in lower range to none in upper range.	90-120 days.	Approximately 50% deaths in lower part of range, increasing toward upper range; all deaths occurring within 45 days.
Greater than 1,000	Severe vomiting, diarrhea, and prostration. Disorientation, lack of muscular coordination, and coma.	Less than 1 hour after exposure.	Progressive incapacitation following an early capability for intermittent heroic response.	Hospitalization required for 100% of exposed personnel. No latent period.	3-30 days.	100% deaths occurring within 30 days.

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of symptoms characterizing an excessive exposure of the entire body or a large part of it to nuclear radiation. The onset of radiation sickness depends primarily on the dose received. Early symptoms are nausea, vomiting, and diarrhea, which may be followed by hemorrhage, inflammation of the mouth and throat, and general loss of energy. At lower dose levels that will cause sickness, several hours might elapse before the severity of the symptoms will make anyone a CI. After the initial period of sickness, a variable latent period is likely during which the individual shows few outward symptoms other than a general lack of well-being. During this middle period, personnel should be able to perform most light tasks. After a week or so, the second and more serious phase of their sickness occurs and lasts several weeks until the person either recovers or dies. As dose levels increase, the pace of illness quickens—the onset occurs sooner and the latent period becomes shorter. Also, the probability of death increases, and the time between exposure and death shortens.

PROTECTIVE SHIELDING

Protective shielding is one method of defense against nuclear radiation. The tremendous penetrating power of gamma rays makes it difficult to provide enough shielding to protect personnel from gamma rays. However, the structure of the ships provides some protection.

The main materials likely to provide shielding aboard ship are steel plating, piping, machinery, water, fuel oil, and perhaps wood. Shielding materials at shore facilities also include concrete and earth.

The amount of shielding required to stop gamma rays is measured in half-value layer thicknesses or "half-thicknesses," for short. A half-thickness is defined as the amount of material necessary to cut down the amount of radiation to one-half of its original value. The half-thickness for each material is different. For example, a concrete shield about 6 inches thick or an earth shield about 7 1/2 inches thick will cut the gamma radiation in half. Suppose that you are in a place where the gamma radiation exposure is 400 roentgens. If you are behind a half-value layer thickness at the time, you will receive a dose of 200 roentgens. Now suppose you are standing behind two shields, each of which is a half-thickness. The 400 roentgens of gamma radiation is reduced to 200 roentgens by the first half-thickness and then to 100 roentgens by the second half-thickness. With each additional half-thickness shield, you reduce the remaining gamma radiation by half. Remember that these thicknesses do not stop gamma radiation completely; instead, each cuts it in half. In a nuclear attack, one half-thickness of steel or concrete might be enough shield to keep you from getting a lethal dose of gamma radiation.

The half-thicknesses of some materials are estimated below. Note that initial radiation is more penetrating than residual radiation and requires a larger thickness to reduce the radiation to one-half of its original value. These materials are listed in the order of their effectiveness as shields against gamma radiation.

	INITIAL	RESIDUAL
Steel	1.5 inches	0.7 inch
Concrete	6.0 inches	2.2 inches
Earth	7.5 inches	3.3 inches
Water	13.0 inches	4.8 inches
Wood	23.0 inches	8.8 inches

RADIAC INSTRUMENTS

Nuclear radiation cannot be detected by any of the five senses. Therefore, special instruments and devices have been developed to do this job. From the military standpoint, we not only need to detect radioactivity, we need to know where the radiation is and what the intensity is. Radiation detection, indication, and computation (radiac) instruments serve both of these needs. Radiac instruments are designed to perform the following functions:

- Detect alpha, beta, gamma, and neutron radiation
- Measure the intensity of radiation
- Measure radiation dose
- Determine the extent of contamination

- Provide information for calculating the length of time that the contamination will exist in the area

- Determine the effectiveness of decontamination measures

The following information will cover specific radiac instruments that you may use. The *Naval Ships' Technical Manual*, chapter 070, also has information on radiacs.

TYPES OF RADIAC INSTRUMENTS

The detection of nuclear radiation is of vital importance to personnel. Serious injury or death can result from exposure to sufficient quantities of these invisible rays and particles. In considering the effects on personnel exposed to radiation, we need two kinds of information: (1) the intensity of the radiation field and (2) the total dose or quantity of radiation received per exposure or time interval. Intensity may be defined as the strength of the radiation. It is expressed as a quantity of radiation per unit of time. The quantity unit used is the roentgen or the rad, and the time unit is usually the hour. Therefore, intensity is expressed as roentgens per hour (R/hr) or as rads per hour (rad/hr). Dosage is expressed in two values; the exposure dose, which is measured in R, and the absorbed dose, which is measured in rad. An added factor in the use of rad is that it expresses the dose from any type of radiation, whereas the R relates only to gamma radiation or X rays. A large number of detection devices scaled in R are still in use. Therefore, R will be used in this book along with rad. The rad and R may be assumed to be equivalent for the purpose of the manual.

Information on intensity and dosage is essential in measuring the extent and degree of radiological contamination. It permits the calculation of safe entry time and stay time for personnel in contaminated areas. Also, it provides an objective means for withdrawing personnel who are nearing the critical point of radiation exposure. Finally, it is useful in anticipating the severity of radiation sickness. Data needed for these and other calculations can be gathered by various radiac instruments.

No hand-held radiac available for military use will measure both radiation intensity and dose. Therefore, the different kinds of measurements must be made by separate instruments. The device that measures radiation intensity is called a dose rate, or survey, meter. It provides the information needed to calculate the radiological hazards of occupying a contaminated area or handling contaminated equipment. It also provides the information necessary to calculate the approximate length of time personnel can safely remain in a radiologically contaminated area. The device that measures the total radiation received by an individual is called a dosimeter. Medical officers must have dose information to predict the severity of radiation sickness, to make the prognosis, and to provide appropriate medical treatment.

The two types of radiation detection and measuring instruments may be compared to automobile speedometers and odometers (mileage indicators). The dose rate, or survey, meter measures the intensity of radiation in R/hr or rad/hr and is like the speedometer that indicates the speed of an automobile in miles per hour. The dosimeter measures the total exposure in R or in rad, without regard to time. Therefore, it is like the odometer which records the total distance traveled in miles, without regard to time.

Fixed radiac systems are installed on most Navy combatants. The instruments provide information on gamma dose rates at the location of the detector and at the main readout installations, usually the bridge area and DCC. The information from these instruments may be used to estimate the dose rates at locations on the ship other than the bridge.

SURVEY METERS IN NAVY USE

Areas are monitored for radioactivity by means of survey meters (dose rate meters). Field monitoring will reveal not only the extent of the radiological contamination but also how "hot" various parts of the area really are. The term *hot*, when used in reference to radiological contamination, means that a certain area has a high contamination reading. Survey meters are also used to monitor food, water, and the skin and clothing of personnel for radiological contamination.

The Navy has radiacs that can be used to make alpha, beta, gamma, and neutron surveys. The following sections discuss the survey meters currently used by the Navy. No attempt has been made to discuss the specialized radiacs used around nuclear power plants or propulsion units.

Alpha Meters

The alpha particle is a relatively large and heavy nuclear particle that has a short range in matter. The alpha particles that you will most likely encounter are the 5.1 MeV alpha particles emitted by plutonium-239. Alpha particles of this energy can be stopped by a sheet of paper or ordinary clothing. These alpha particles have a range of only about 1 inch in air. Because of the short range of alpha particles in air, alpha detectors must be placed within one-eighth to one-quarter of an inch from the surface being surveyed.

The AN/PDR-56 (series A through E and G through H) (fig. 8-8) is the Navy's standard alpha survey meter. It is used to locate and measure alpha contamination of (1) the skin and clothing of personnel and (2) the surfaces of equipment, buildings, or land.

The detector of an AN/PDR-56 is of the scintillation type. Alpha scintillation detectors are extremely fragile devices by necessity. Detection involves (1) the release of alpha particle energy in a phosphor with the resultant production of a scintillation of light and (2) the conversion of the energy in the light scintillation to electrical energy in a photomultiplier (PM) tube. Since the PM tube is light sensitive, the phosphor must be protected from ambient light. A very thin (approximately 0.00025 inch thick) Mylar film, coated on both sides with evaporated aluminum, is placed over the detector. The Mylar film provides the required light protection of the PM tube. Thus, a practical scintillation detector requires that the phosphor be protected from external sources of light and at the same time be sufficiently thin to permit the transmission of alpha particles. The fragile Mylar film is presently the best material available for alpha detector "windows."

The AN/PDR-56 has a meter readout calibrated in four ranges of counts per minute (c/min): 0 to 1,000, 0 to 10,000, 0 to 100,000, and 0 to 1,000,000. These values are directly related to surface plutonium-239 contamination levels of 0-10, 0-100, 0-1,000, and 0-10,000 micrograms per square meter (ng/m^2).

Beta-Gamma Radiacs

The radiacs described in the following paragraphs can detect and measure both gamma and X rays. The detecting elements of some of these instruments are so constructed that by moving an integral shield (the beta shield), an operator can

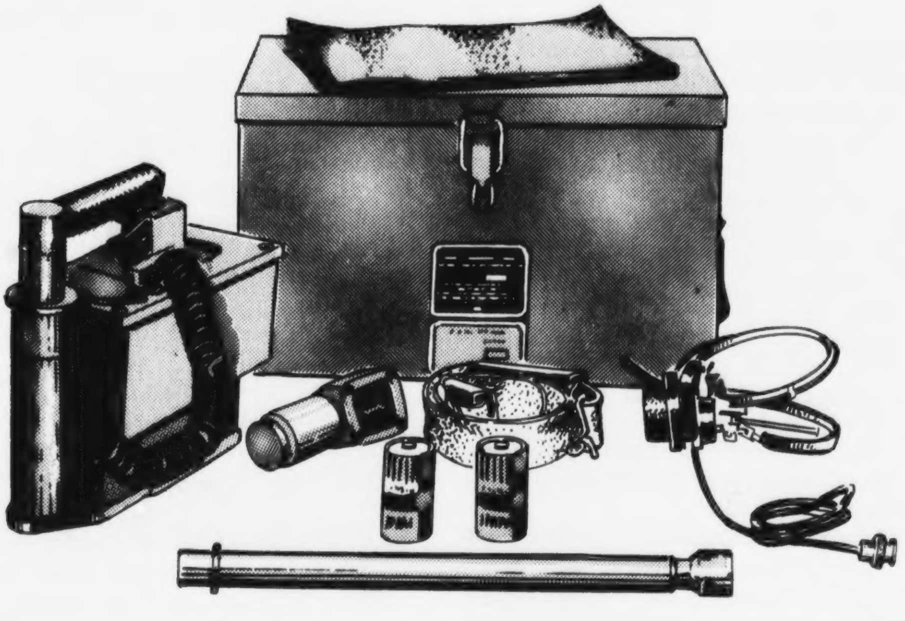

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Figure 8-8.—AN/PDR-56.

expose the ports to the sensitive volumes of the detectors. This permits the detection of beta particles along with gamma rays. Judicious use of the beta window permits an operator to determine if a surface is contaminated with a beta or a low-energy gamma-ray emitter.

AN/PDR-27.—The AN/PDR-27 (series J through S) (fig. 8-9) is a portable, watertight, battery-powered, low-range survey radiac. Two Geiger-Mueller (GM) tubes are mounted in an extendable probe. A spare Geiger-Mueller tube set is included in the carrying case. The probe is fitted with a beta shield. Six alkaline D-cell batteries (BA-3030/u) power the unit. If the alkaline batteries are unavailable, you may use carbon-zinc, D-cell batteries (BA-30). The AN/PDR-27 provides both visual and audible indications of gamma and beta radiation levels. The visual indication is shown on a meter. The audible indication is heard through a headset. The radiation measurement is in milliroentgens per hour (mR/hr). The unit is capable of detecting and measuring gamma radiation when the beta shield is in place. It is also capable of detecting beta and gamma radiations together when the beta shield is removed. There are four linear scales on the AN/PDR-27. The scales are 0 to 0.5 mR/hr, 0 to 5 mR/hr, 0 to 50 mR/hr, and 0 to 500 mR/hr. Beta radiation can be detected on the lower two scales only.

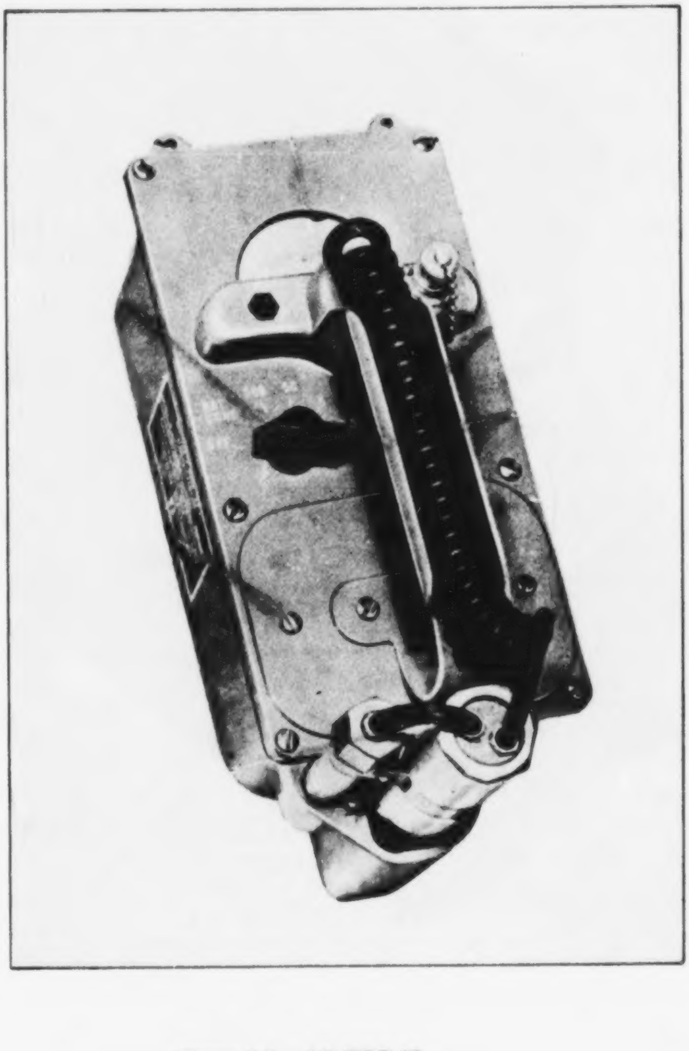

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Figure 8-9.—AN/PDR-27.

AN/PDR-43.—The AN/PDR-43 (series A through E) (fig. 8-10) is the standard Navy high-intensity survey meter. It is a portable, watertight, battery-powered, high-range survey radiac. The detector consists of one GM tube which is installed in the forward end of the radiac. The detector has a beta window and a movable beta shield. An internal radiation check source is provided so you can conduct an operational check of the unit. The check source actuator is spring-loaded so that the detector responds to it only when you so desire. Two alkaline D-cell batteries (BA-3030/u) power the radiac. You may use two carbon-zinc, D-cell

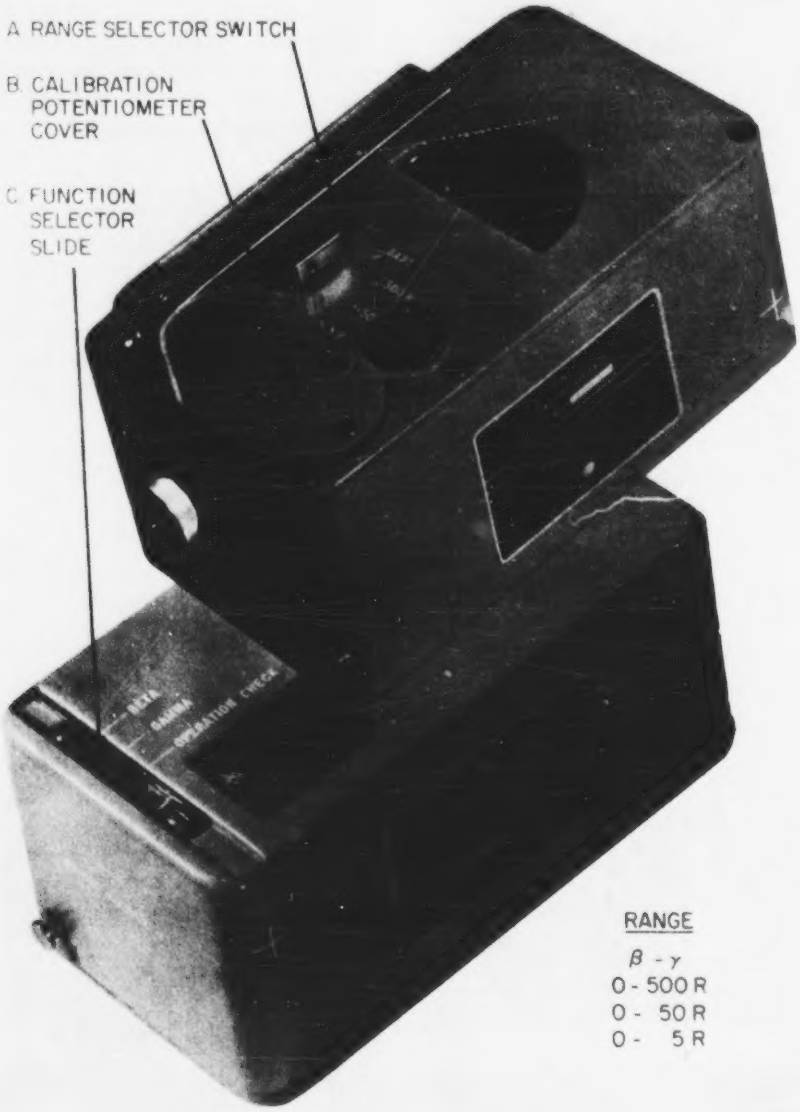
A RANGE SELECTOR SWITCH
B CALIBRATION POTENTIOMETER COVER
C FUNCTION SELECTOR SLIDE
BETA
GAMMA
OPERATION CHECK
RANGE
β - γ
0 - 500 R
0 - 50 R
0 - 5 R

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Figure 8-10.—AN/PDR-43.

batteries (BA-30) if alkaline batteries are not available.

The AN/PDR-43 is capable of detecting and measuring gamma radiation alone. The unit can also detect gamma and beta radiations combined. The unit has three meter scales. The scales are 0 to 5 R/hr, 0 to 50 R/hr, and 0 to 500 R/hr. The AN/PDR-43 has a range selector switch which has five positions. These positions are OFF, BATTERY, 500 R, 50 R, and 5 R. On the bottom of the radiac is a function selector switch. This switch has three positions: BETA, GAMMA, and OPERATION CHECK. When the function selector switch is in the GAMMA position, only gamma radiation is detected by the GM tube. When it is in the BETA position, the end window of the GM tube is exposed to detect beta and gamma radiations combined.

AN/PDR-65.—The AN/PDR-65 (fig. 8-11) is designed to detect and measure gamma radiation. The set consists of two primary elements—the detector unit and the radiacmeter.

The detector unit must be located at or near a masthead. Its view of an enveloping base surge cloud and resultant fallout must be relatively unobscured. As a result, if suitable scaling factors are available, gamma dose rates at any location inside the ship can be estimated from the masthead radiation intensity data.

The radiacmeter is to be installed on the bridge. One or more auxiliary readouts are to be located in DCC and other prime locations. The radiacmeter has two types of displays; one is for dose rate and the other is for accumulated dose. The main meter displays the dose rate. The small counter registers the accumulated dose in rads by counting the rad pulses from the detector. Each

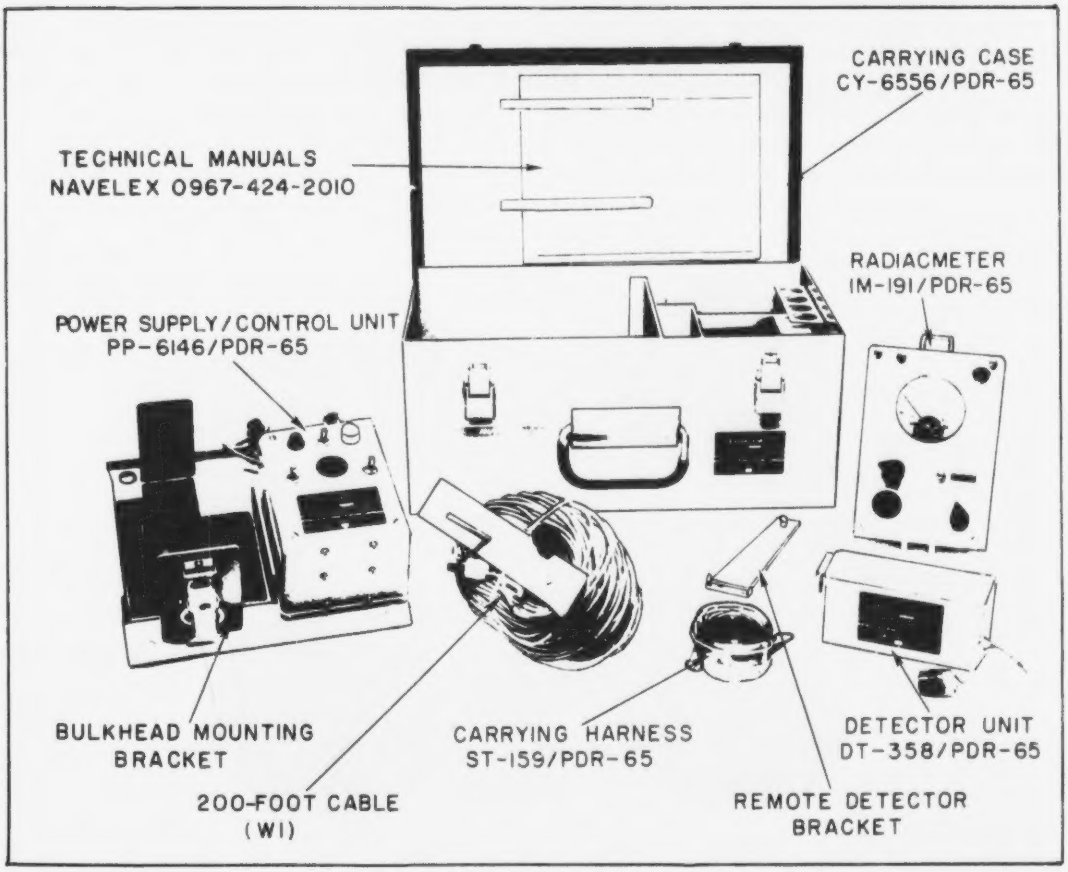
CARRYING CASE
CY-6556/PDR-65
TECHNICAL MANUALS
NAVELEX 0967-424-2010
RADIACMETER
IM-191/PDR-65
POWER SUPPLY/CONTROL UNIT
PP-6146/PDR-65
BULKHEAD MOUNTING
BRACKET
CARRYING HARNESS
ST-159/PDR-65
DETECTOR UNIT
DT-358/PDR-65
200-FOOT CABLE
(W1)
REMOTE DETECTOR
BRACKET

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Figure 8-11.—AN/PDR-65 radiac set.

time that a dose of 1 rad is accumulated, the radiacmeter sounds a loud beep. The range of the small counter is 0 to 9,999 rad. Gamma intensity is indicated on one of the following four ranges: 0 to 10 rad/hr, 0 to 100 rad/hr, 0 to 1,000 rad/hr, and 0 to 10,000 rad/hr.

For normal operation, the AN/PDR-65 is powered by the 115 vac ship's power. In an emergency, the radiac operates on four internal, rechargeable, nickel-cadmium, C-cell batteries which are on floating charge. The batteries can power the radiac for approximately 20 hours.

Dosimeters

A number of types of radiation dose-indicating devices (dosimeters) are in the Navy radiac system. Dosimeters of interest to the Damage Controlmen are the DT-60/PD, the IM-9/PD, and the IM-143/PD.

DT-60/PD.—The DT-60/PD (fig. 8-12) is a gamma radiation dosimeter with a usable range of 10 to 600 R. It is a solid-state package in the form of a locket. It is designed to be worn on a chain around the neck. Inside the black plastic casing is a phosphate glass. When the phosphate glass is exposed to ultraviolet light, it emits an orange light. The intensity of the orange light is proportional to the amount of radiation the glass has received. The DT-60/PD stores the dose information indefinitely and is a permanent record of the amount of exposure to radiation.

The CP-95/PD (fig. 8-13) is a radiac computer-indicator that is used to read the amount of radiation a DT-60/PD has been exposed to. A newer model, the CP-95A/PD (fig. 8-14), is also available. The cover on the DT-60/PD must be removed before the DT-60/PD is inserted into the radiac computer-indicator. Each of these radiac computer-indicators has two scales: 0 to 200 R and 0 to 600 R. However, 10 R is the minimum detectable exposure. These units have an accuracy rate of ±20 percent. The radiac computer-indicators operate off of the ship's 115 vac power source.

IM-9/PD.—The IM-9/PD (series E through H) is a pocket dosimeter of the quartz-fiber type. It indicates the gamma radiation dose in the range of 0 to 200 mR. The IM-9/PD is a self-reading dosimeter. By holding the dosimeter up to the

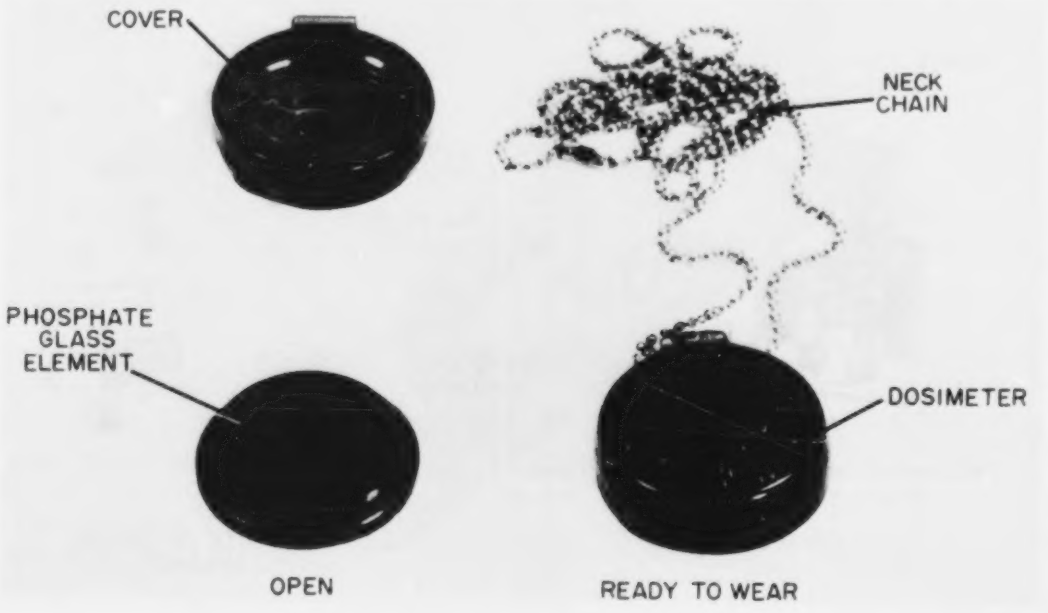

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Figure 8-12.—High range or casualty dosimeter (non-self-reading) DT-60/PD.

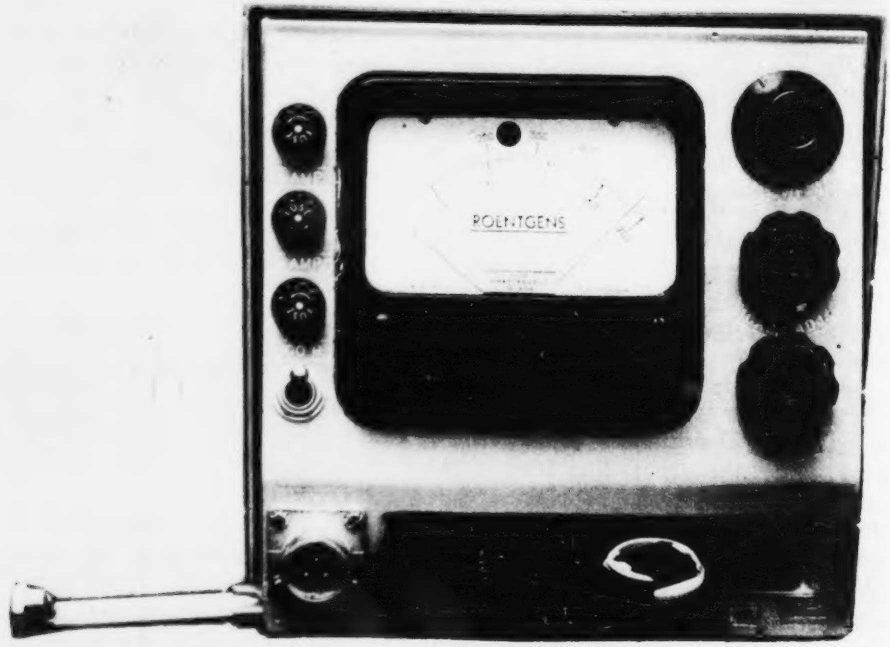

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Figure 8-13.—Radiac Computer-Indicator CP-95/PD, front panel controls and receptacles.

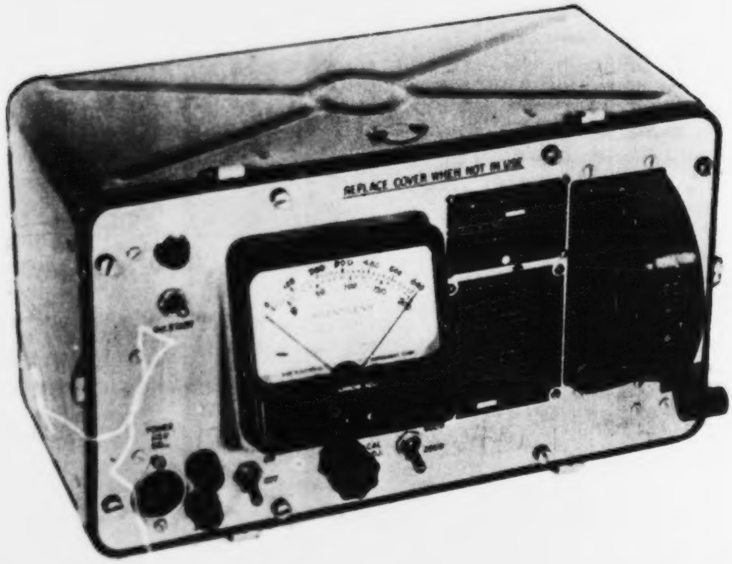
REPLACE COVER WHEN NOT IN USE

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Figure 8-14.—Radiac Computer-Indicator CP-95A/PD.

light and looking through the lens (fig. 8-15), you can read the radiation dose received. The reading is obtained by observing the position of the quartz fiber on the scale of the built-in optical system. The IM-9/PD is primarily a health-physics device that is particularly useful in areas of low dose rates.

IM-143/PD.—The IM-143/PD is identical to the IM-9/PD except in range. The IM-143/PD indicates gamma radiation dose in the range of 0 to 600 R. It is used by repair locker personnel that are involved with the survey, monitoring, and the decontamination details during CBR evolutions. It keeps track of the dose they have received up to the time they read the dosimeter.

The PP-4276A/PD dosimeter charger (fig. 8-16) is used to reset the self-reading dosimeters to zero. This is accomplished by placing the dosimeter into the charger. The charger provides an adjustable voltage source that is applied between the central wire and the shell (fig. 8-17). Because the quartz fiber and the fixed central wire of the ion chamber are attached, each will receive the same charge. As a result, when the dosimeter is charged, the movable fiber is repelled from the fixed wire. By proper adjustment of the voltage applied by the charger, the fiber can be set exactly on the zero line of the scale. When nuclear radiation enters the chamber, ions are produced and are attracted to the wire and the shell. The charge is thus reduced; the fiber then moves across the scale because it is not as greatly repelled from the fixed wire as it was previously. The power source for the PP-4276A/PD is one alkaline D-cell battery.

When you charge a dosimeter with the PP-4276A/PD, use the following procedures:

1. Remove the dust cover from the charger receptacle.
2. Place the electrode end of the dosimeter into the charging receptacle and depress it firmly. This illuminates the dosimeter scale and operates the charger.

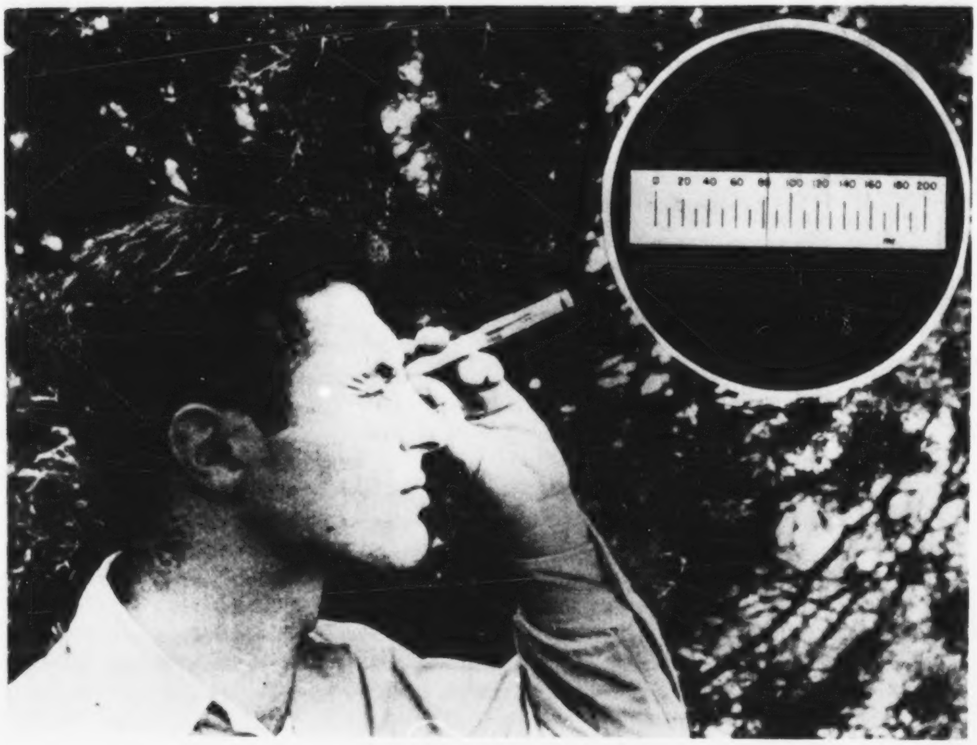

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Figure 8-15.—Method of reading IM-9/PD dosimeter by looking through it at the light. Insert shows a dose reading of 82 mR.

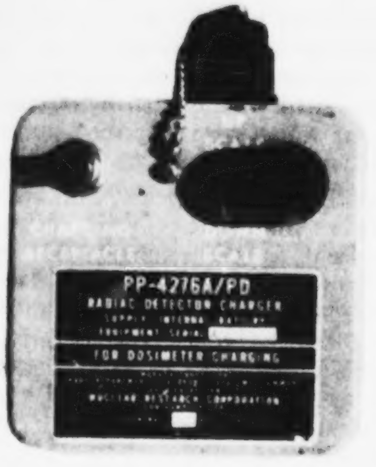

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Figure 8-16.—Dosimeter Charger PP-4276A/PD.

3. Rotate the charging knob until the hairline on the meter scale is located on the zero mark.
4. Remove the dosimeter from the charger and check to ensure that it is still on zero.
5. Replace the dust cover on the charger.

LIMITATIONS OF RADIAC INSTRUMENTS

Remember that although we have radiac equipment to detect and measure nuclear radiation, these instruments do have some limitations.

None of these instruments is capable of detecting and measuring alpha, beta, gamma, and neutron radiation at the same time. Even those that can detect both beta and gamma radiation do not automatically separate these two types of radiation for us. Instead, the operator keeps beta particles from entering the chamber by manually pulling a *beta shield* over the thin window in order to get a *gamma* reading only. Otherwise, you would get a combined reading. A separate instrument is used to measure alpha radiation.

CALIBRATION AND REPAIR OF RADIAC EQUIPMENT

Radiac equipment aboard ship is checked as required by the *Ships' Maintenance and Material Management (3-M) Manual*. Ashore, radiac equipment is checked at least once each month or at intervals specified by the applicable technical manual. This check is accomplished in accordance with instructions contained in the operator's section of the technical manual.

Radiac equipment must be temporarily transferred at regular intervals by shore activities to a radiac repair facility for maintenance and calibration. Ships, as far as practical within their operating schedules, also must transfer their radiac instruments to repair facilities for maintenance and calibration. When equipment requiring outside maintenance is found to be inoperative or is suspected of malfunctioning, it should be sent to the radiac repair facility immediately.

Routine maintenance should be performed on the radiac equipment as described in its technical manual. (See also any appropriate directives.) You may change the radiac's batteries if they are weak. However, changing batteries does not eliminate the need for routine maintenance. Some of these

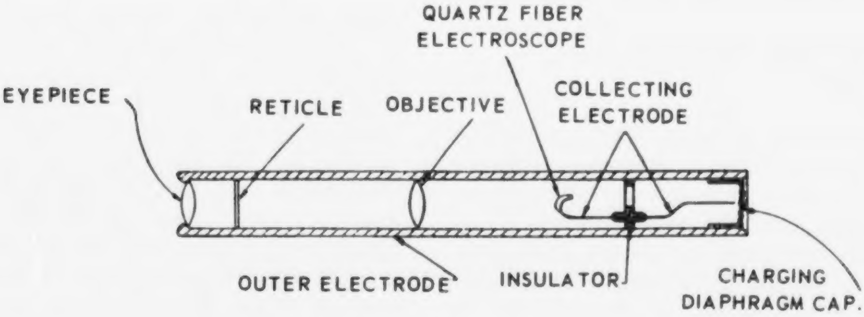

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Figure 8-17.—Cutaway diagram of an IM-143/PD pocket dosimeter.

instruments have complicated electronic circuits that may carry high voltages. Other instruments contain radioactive material inside that presents a potential hazard to untrained personnel who take them apart. All radiac equipment that operates on direct current is designed so you can replace the batteries without exposing the internal circuitry or making the radiation hazard more dangerous.

The following checks should be made at least monthly:

- Battery check.
- Function check.
- Ensure instrument is turned off.
- Ensure instrument is stored in cool, dry place. (Air-conditioning is not a requirement.)

RADIOLOGICAL MONITORING

Intensity and dose measurements are required when a radiation hazard exists. Measurements should be started before the expected arrival of the fallout and continued regularly until the ship has been granted an operational clearance. At early times after the burst (emergency phase), rapid simple measurements are required. At later times (operational recovery phase), the required measurements will range from simple to very detailed. This section is concerned with monitoring surveys in the operational recovery phase. However, you can usually take advantage of measurements made in the emergency phase.

Surveys aboard ship require specific techniques for measuring radiations that produce penetration doses and skin doses.

RADIATION-MONITORING PROCEDURES

The hazards of radiation and radioactive contamination are different from most ordinary hazards in that the former are usually invisible. However, instruments have been developed to measure radiation, and techniques have been developed to estimate the amount of removable contamination. Therefore, the hazards can be identified, their importance can be estimated, and they can be dealt with in a systematic fashion. This section describes techniques for measuring radiation and contamination. These measures provide the information necessary to identify the radiation hazards and bring them under control.

Radiacs provide intensity and exposure information on radiation hazards. The two basic types of radiacs used are the intensity meters and the dosimeters which were described earlier in this chapter.

Radiation measurements can be only as accurate as the radiacs used to make the measurements and the techniques used to operate the radiacs. Some radiacs detect the ionizing property of radiation, which is an electrical phenomenon. They convert this property, through electronic circuitry, to a visible indication. Other radiacs, such as the DT-60/PD dosimeter, depend on chemical changes due to ionization rather than on electrical effects.

Most radiacs with electronic circuitry are somewhat delicate and should be handled with care. Gamma-measuring radiacs are the sturdiest. Beta-detecting radiacs usually have detectors with thin glass walls. This delicate detector is visible when the beta window of the AN/PDR-27 detector probe is open. Alpha-measuring radiacs are the most delicate. The detector probe of this type of radiac has a window which is very thin. This allows the short-range alpha particles to pass through it into the detector. However, this window must be gastight to prevent the escape of the special gases used in the detector. Those who use radiacs should be well acquainted with the particular precautions to be taken with each type assigned to them.

Take precautions to avoid contaminating a radiac's detector probe. A contaminated detector probe will give high radiation readings. These readings might be interpreted incorrectly as contamination on the surface being monitored. Contamination of a detector probe can be avoided in two ways: (l) by covering the radiac and (2) by not touching contaminated surfaces with the detector probe. Gamma radiacs can be covered by any convenient material. Transparent polyethylene bags are generally found to be most satisfactory. The instrument dial can be read and the control knobs can be operated through the bag. The bag can be changed periodically. The detector of beta radiacs can be protected from contamination by using a layer of thin plastic film, such as Mylar. The detector of an alpha radiac cannot be covered because the cover would reduce the sensitivity of the instrument too much and readings would be incorrect.

Use a standardized monitoring procedure for each type of radiation survey to ensure the maximum value of the radiation data. A uniform monitoring technique will use no more time or effort than a random procedure, and it may actually save time.

General shipboard preattack preparations for radiation monitoring surveys include these steps:

- Establish monitoring points
- Maintain radiacs
- Select a laboratory-type area for analyzing wipe samples
- Prepare masters for data forms
- Perform monitoring exercises

Establish monitoring points in compartments or areas that are vital action stations. Examples are living quarters, sick bay, messing areas, shelter compartments, and a few representative deck areas. Each point should be representative of the location of personnel occupying the compartment or area. Identify the points by a distinctive label that includes the location mark and an identifying number. (The identifying number can be the same as the compartment identification unless more than one monitoring point is in the compartment). The number of monitoring points should be the least number that will give a good sampling of the condition of vital stations. The number should also ensure that a complete monitoring survey can be made with only a few monitoring teams in about 10 minutes.

Test and maintain radiacs routinely to ensure proper functioning and to stay familiar with their operation.

Select a laboratory-type area for analyzing wipe samples and fallout samples. The area should have a desk or workbench and be located in a shielded compartment. If wipe samples are to be saved, store them apart from the analysis instrument so that they will not increase the background radiation intensity.

A ship should use training exercises to establish a pattern for calculating and reporting radiological information. When that has been done, prepare masters of data sheets for each step of monitoring, calculation, and reporting procedures (together with a small supply of copies) and keep them on file.

A shipboard or shipyard monitoring team consists of two personnel: a radiac operator (or a dosimeter reader or a wipe sampler, depending on the type of survey being made) and a recorder. The monitoring-team members should be dressed in protective clothing if they are to go into an area suspected of being contaminated. For rapid monitoring, the team should have specific monitoring points to survey. They should travel a previously practiced route (or an agreed-upon route if the previously practiced route cannot be used). The recorder should try to keep his hands and the data sheets from becoming contaminated so that the data sheets can be used in a clean office area.

A reminder list of rules and guidelines for the use of radiacs while performing monitoring surveys follows:

BEFORE ENTERING THE RADIATION AREA

- Select the type of radiac that will measure the type of radiation known to be present (use beta/gamma instruments for fission products, and beta/gamma and alpha instruments for weapon incidents/accidents).
- Select the radiac model that has an indicating range broad enough to measure the radiation intensity of the area to be surveyed.
- Test the radiac for proper operation.
- For each survey point, use the lowest range of scaling factor that will give an on-scale reading.
- Record the exact time of departure (and of return) on the data form.

DURING THE SURVEY

- Protect the radiac from contamination.
- Be alert for hot spots and note their location. (Don't spend time searching for hot spots unless so directed.)
- Read the radiac to the nearest scale division (these instruments are designed for about ±20 percent accuracy).
- In detailed monitoring surveys, proceed slowly and carefully. Thoroughness is more important than speed. For each reading, hold the

radiac steady and allow enough time for the meter to reach maximum deflection. This generally takes no more than 8 to 10 seconds and usually only 3 or 4 seconds.

Topside Gamma Monitoring

This monitoring procedure is a routine action for providing a preattack baseline value of the gamma-radiation level in the vicinity of the open bridge or quarterdeck of a ship. It also provides data to detect the start of transit radiation, to detect the arrival of fallout during the very early time period after burst, to determine the end of fallout and/or base surge, and to determine the approximate effectiveness of whole-ship decontamination operations.

Record readings of open-bridge or quarterdeck gamma intensity routinely. Do this at the beginning of each watch, minimum; every 5 to 10 minutes when fallout is imminent; and every 2 minutes or whenever the radiation level changes by 20 percent (whichever is longer) following fallout. The interval between readings may be increased or decreased by the commanding officer in accordance with the present circumstances. If base-surge contact is presumed possible, monitoring should be performed continuously, noting the peak(s) and the time(s) of the peak(s).

Radiacs currently used for this monitoring requirement include the ship-installed AN/PDR65, and the portable AN/PDR-27 and AN/PDR-43.

The data recorded are the ship's location, date, hour, radiation-intensity reading, and radiac used. For example, latitude and longitude, 9 Sept 19XX, 08XX, 0.05 R/hr, AN/PDR-27J, Serial XXX.

Reporting procedures should be established prior to an attack. These procedures should include who is to be notified when the postattack gamma intensity changes by some proportional amount (such as every time the radiation intensity doubles or halves.)

Area Gamma-Exposure Monitoring Survey

Locate dosimeters at monitoring points in deep shelter and at vital topside and below-deck spaces. Readings can then be made to determine the total gamma exposure from the initial, transit, and deposited radiations, as well as routine space checks. The data serves primarily as a rapid check of the exposure levels at various points throughout the ship to identify gamma-radiation-hazard areas for assessing the shipboard radiological situation.

The data will not normally be used to estimate specific doses to personnel. However, if an individual had a malfunctioning dosimeter or none at all, a rough estimate of the individual's dose could be obtained from this survey. Preattack monitoring can be used to identify faulty dosimeters. Exposure readings are also checked routinely at certain stations (such as living spaces) to ensure that low-intensity gamma radiation undetected by other surveys is not a long-term hazard.

Two methods can be considered for area exposure monitoring:

1. The preferred method is to have one set of dosimeters and several spares. Read and record each dosimeter periodically. If a dosimeter shows over 50 percent of full-scale exposure, replace it with a fresh dosimeter.
2. The second choice is to have two sets of dosimeters for each station to be monitored. Place one set on the station and keep the second set in reserve. Collect the exposed dosimeters periodically, and replace them with the freshly charged reserve set. Take the exposed dosimeters to a central location to read and record the exposures.

All self-reading dosimeters (such as the IM-9/PD and the IM-143/PD) can be used for area exposure monitoring. Monitor selected action stations with both a low-reading and a high-reading dosimeter.

Rapid Interior Gamma-Monitoring Survey

Conduct a rapid monitoring survey to determine the gamma-radiation levels in shelters and at vital action stations. This survey provides the gamma-intensity readings necessary to make a radiological-situation evaluation and to plan personnel rotation or calculate recommended maximum stay times. When this survey is made before and after a decontamination pass, and the standard intensity results are determined from the survey, the residual number of the decontamination operations can be calculated.

This survey should be completed in about 10 minutes or less. The results should be immediately transmitted to the designated central-control point. This rapid interior gamma-monitoring survey can be combined with an area-exposure monitoring survey to obtain all the radiation data required for the radiological-situation evaluation.

When performing this rapid monitoring survey, observe the general rules for monitoring. In addition, when reading gamma-radiation intensity, be sure that the beta shield covers the detector if the radiac is so equipped. Hold the radiac at waist height over the designated monitoring point. Make the reading when the indicating needle steadies. Monitoring teams operating earlier than 1 hour after burst should record the time of reading within an accuracy of 1 minute. Monitoring teams operating at times later than 1 hour after burst should record the time of reading within an accuracy of 5 minutes. This procedure applies to all gamma-intensity radiacs, such as the AN/PDR-27 and the AN/PDR-43.

Rapid Exterior Gamma-Monitoring Survey

There are three primary purposes for the rapid exterior gamma survey. The first is to obtain data for evaluating the radiological situation at exposed action stations. The second is to locate the general deck areas most in need of decontamination. The third is to determine the effectiveness of a decontamination pass. The personnel on the monitoring teams must be dressed in CBR protective clothing. They should use the designated entrances and exits through the personnel decontamination stations. For their safety, the personnel should wear an IM-143/PD self-reading dosimeter and read it often while conducting the surveys.

Except for the above precautions, the procedure for the exterior survey is the same as that for the interior survey.

This survey technique is also applicable to the radiological recovery of ships at shipyards. However, a shipyard may find it useful to increase the number of monitoring points. Monitoring points spaced 6 feet apart on a square pattern will give excellent resolution of the distribution of radiological contamination. However, this can be too time-consuming except for small ships. The monitoring point spacing can be increased to 12 feet without undue reduction of resolution. On carrier flight decks, a 25-foot spacing is adequate.

Rapid Contamination Survey

The purpose of this survey is to obtain samples required to quickly identify areas having removable contaminants. The wipe sample is useful for detecting the presence of contaminants from a weapon-handling accident (alpha) and/or from fallout (beta-gamma). This survey should be made after any event suspected of contaminating the ship. It should be repeated after known or possible significant changes in the amount or distribution of contamination. An example would be after a decontamination operation or after a suspected scattering of the contaminant through previously clean areas. The survey involves the taking of wipe samples in various areas of the ship.

The procedure for taking wipe samples requires a two-person survey team. These personnel should wear protective clothing when they survey the contaminated areas of the ship or when they attempt to determine the contamination limits. The equipment needed for sampling includes filter papers or absorbent papers such as paper towels (about 3 by 3 inches) for wipes and for beta-contamination samples. You will need an equal number of envelopes to contain the wipes, a pencil and a clip board to mark the envelopes, and a stapler to seal the envelopes. One team member, designated the sampler, will take all the wipe samples. The other team member, designated the recorder, will seal the samples in the envelope after marking the envelope. A sample is taken by wiping the clean piece of absorbent paper lightly over a 16-square-inch area (for example, a 4- by 4-inch area) of the surface being surveyed. Generally, in a rapid contamination survey, wipes are taken only of deck areas. The recorder holds the envelope open, and the sampler drops the sample into the envelope. The recorder then seals the envelope by stapling, taping or folding it closed—never by licking the gummed flap.

To determine the boundaries of the contaminated area, take samples from several types of areas such as the following:

1. Important areas presumed to be clean. Examples are mess halls, the sick bay, living quarters, machinery spaces, the bridge, and so forth.
2. Areas that might be contaminated. These areas would be selected on the basis of the circumstances. They should include areas that had some traffic after the presumed contaminating event. Examples are passageways to the exterior of the ship and compartments that were open or ventilated during the contamination event.
3. Areas presumed to be contaminated. After fallout, these would include selected action stations on the weather deck; after a weapon-handling accident, these would include areas near the accident scene.

Several survey teams might be dispatched—one for each type of area. If only one survey team is available to take samples, the team should take the samples in the order given above and should not mix the samples.

The wipe samples protected by the envelopes should then be taken to a low-radiation-level area for radiation-intensity measurements. The radiation intensity of samples of fallout contamination should be measured while they are in the envelope. Measure the radiation intensity with a beta-gamma instrument, such as the AN/PDR-27 or AN/PDR-43 radiac. Be sure that the open beta window is in contact with the envelope. Always use the same radiac instrument. Before samples are read, take and record an initial background reading. Subtract this background reading from the gross sample reading to get a net sample reading. The background reading is merely a radiation reading with no sample present and should be taken about every 10 minutes when a series of samples is being analyzed. Figure 8-18 is an example of the data form.

Alpha wipe samples can be read as they are taken. Place the wipe sample on a flat surface with the wiped side facing up. Place the probe within one-eighth inch of the sample's surface. Allow 3 to 5 seconds for the alpha radiac to stabilize before you record the reading.

Personnel-Exposure Survey

The purpose of a personnel-exposure survey is to make a direct estimate of the radiation exposures of ship's personnel. This estimate is made by reading and recording the exposures indicated by the dosimeters worn by one or more persons in each team.

Protective actions, such as personnel rotation, are based in part on personnel dosimeter readings. For this reason, readings of dosimeters must be made quickly to allow adequate planning time. The interval between dosimeter checks will depend on the intensity levels where personnel perform duties, on previous individual exposures, and on the designated planning exposure. The method of

INSTRUMENT MODEL # ____________________

SERIAL NUMBER ____________________

DATE ____________________

OPERATOR ____________________

HOUR	SAMPLE NO.	SAMPLE LOCATION	BACKGROUND		GROSS SAMPLE		NET SAMPLE		NOTES
			SCALE	READING	SCALE	READING	SCALE	READING	

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Figure 8-18.—Data form for wipe sample analysis.

determining the maximum interval between readings is as follows:

$$\text{Time between readings (hr)} = \frac{\text{Planning exposure} - \text{exposure to date (R)}}{\text{compartment intensity (R/hr)}}$$

Example:

$$\begin{aligned} \text{planning exposure} &= 10\ \text{R} \\ \text{compartment intensity} &= 8\ \text{R/hr} \\ \text{prior exposure} &= 4\ \text{R} \\ \text{Time between readings} &= \frac{10\ \text{R} - 4\ \text{R}}{8\ \text{R/hr}} \\ &= 3/4\ \text{hr} \end{aligned}$$

For the above example, the dosimeter should be read and recorded at least every 45 minutes.

The dosimeters to be used should be specified. The DT-60/PD personnel dosimeter can be read rapidly with the CP-95/PD radiac computer-indicator. When readings are required on a minute-to-minute basis, use a self-reading dosimeter, such as the IM-143/PD.

The exposure of personnel wearing self-reading dosimeters can be monitored in a manner similar to that of the area-exposure monitoring survey. On the other hand, the monitoring of non-self-reading dosimeters is best done at some fixed location, such as at an entrance to a mess hall.

Rapid Alpha-Monitoring Survey

The purpose of a rapid alpha survey is to obtain the data necessary to quickly detect the contaminated areas of a ship after a nuclear weapons accident. The alpha-contamination limit can be delineated at the same time. A rapid alpha survey should take place immediately after the accident and at designated intervals thereafter.

The following procedure should be used to delineate the contaminated areas:

- From the nature of the accident, tentatively identify those areas that almost certainly are not contaminated and also those areas that almost certainly are contaminated.

- Take readings, beginning with the presumed uncontaminated area and working to the presumed contaminated area; space the survey points so that there will be four points between the presumed clean area and the presumed contaminated area.

- Survey first those areas where spread of contamination would be most important.

- Record results of the survey as readings are made; include time, location, meter reading, and notes on any unusual observation.

The technique for taking readings is as follows: Place the probe within one-eighth inch of the surface. Hold the probe in one position for 3 to 5 seconds to allow for the relatively slow response of the alpha radiac. Use earphones if they are available. An alpha reading cannot be taken on a wet surface.

Even though alpha-monitoring teams may be dressed in protective clothing, they should try to stay out of a highly contaminated area because they might spread alpha contamination into the clean area.

Detailed Monitoring Survey

The detailed monitoring survey is a slow, careful inspection of all accessible areas, equipment, and systems that have been exposed to contamination. This survey is generally conducted after the application of countermeasures and toward the end of the operational-recovery phase. The purpose of this survey is to verify the radiological clearance level of various areas on a ship. These checks determine whether or not the next lower clearance level can be assigned to the area, thereby reducing radiological restrictions aboard the ship. After fallout contamination, the survey includes both a beta-gamma radiation survey using radiacs and a contamination survey using wipe samples. After a damaging nuclear-weapon accident, the survey includes an alpha-radiation survey using radiacs and an alpha-contamination survey using wipe samples.

When the general radiation level of the ship has been reduced by decontamination operations, read the wipe samples where they are taken rather than take them to a low-background laboratory-type area.

The detailed survey should include all accessible surfaces (both horizontal and vertical) in suspect areas of the ship. It is especially important to check surfaces and areas that tend to capture and hold dirt, such as rust spots, scuppers, caulking in wood decking, canvas covers, and manila lines. Give extra attention to compartments, such as firerooms, that were ventilated during fallout. The finer fallout particles, which can enter the ship through the ventilation system, tend to settle on horizontal surfaces. They adhere to wire screens, steel wool, and air filters (such as those on electronic equipment). Carefully monitor the ship's sea-water piping systems externally, over all parts from the intake to the outlets. Remove access ports along the ventilation system and take wipe samples of interior surfaces. Take air samples, as described in the air sampling section that follows, at the outlets of any ventilation ducts suspected of being used during fallout.

This gamma monitoring procedure is slightly different from that described under Rapid Exterior Gamma-Monitoring Survey. Hold the gamma detector approximately 2 inches from the surface being monitored. By using this procedure, you can identify a contaminated area 1 foot in diameter or less. You can sometimes further localize a contaminated area by slowly moving a detector probe (with the beta shield removed) over the surface at the 2-inch distance. Identify the contaminated area by marking it with a crayon. For example, you should record the following: the location of the contamination, intensity, method of reading, and date.

Air Sampling

Air sampling has two purposes: to detect the presence of radioactive aerosols created in a contaminated area which may possibly spread to a clean uncontrolled area and to establish the requirement for respiratory protection for personnel working in a contaminated area. Air sampling is applicable to shore-based operations. However, it is also applicable to the testing of the atmosphere of compartments having ventilation intakes downwind of an alpha-contaminating incident (such as a weapon-handling accident).

An air sampler (or more properly, air-particle sampler) draws air through a replaceable filter at a nearly constant rate of flow. With some air samplers, you can read the total volume of air on a digital counter. With others, you can calculate the total volume of air by multiplying the known flow rate by the air-sampling time. You should then remove the filter from the air sampler. Then, collect and analyze the radioactivity of the air particles, using instrumentation suited to the type of contaminant suspected.

Analyze the filter papers from air samplers by the procedures given in the air-sampling instruction. If at all possible, use the type of filter paper recommended by the manufacturer of the air samplers. If that type of filter paper is unavailable, substitute other types of filter paper. However, note that air samplers might give erroneous readings if substitute filter papers are used.

Coarse filter papers will allow the finest particles to pass through. This gives low collection efficiencies as compared to the recommended paper. In addition, coarse papers absorb some of the alpha radiation from contaminated particles that have been collected. Therefore, use of other than recommended papers when sampling air for alpha aerosol contamination can result in readings having a substantial error.

Air sampling can be done in two ways, depending on the size of the operation:

- If the operation being monitored is small, take a sample during the operation, with all workers wearing respiratory protection suitable for the aerosol problem expected. After the sample is analyzed, modify respiratory protection according to the findings.

- If the operation is large, make a pilot run under conditions as realistic as possible. Analyze air samples from the pilot run and project the results to the full-scale operation. Continue air sampling through the full-scale operation, monitoring filter papers periodically as a check on the projection from the pilot run.

While monitoring the spread of contamination, set up the air sampler at a height of about 5 feet, directly downwind from the operation to be monitored but not further than the line demarking the contaminated and clean areas. To monitor the inhalation hazard to operating personnel, set up the air sampler in the highest suspected airborne contamination in which a worker may go.

Fallout Samples

Fallout samples can be taken to check the decay rate of fallout. They can also be used to predict decay better than the assumptions made when measurements are not available. Samples collected before and during the operational-recovery phase will be most useful in planning radiological-recovery operations.

Take a fallout sample in the same manner as for a standard wipe sample except that you should take a larger sample to obtain a high-radiation reading. It is advisable to obtain a fresh sample each time the ship is decontaminated. Decontamination can selectively remove certain radioisotopes and thereby change the decay rate of the remaining mixture of radioisotopes.

Analyze samples by using laboratory counting techniques. If a laboratory counter is not available, use the procedure for analyzing wipe samples but cover the detector with the beta shield. Plot the net readings on log paper. An example of this type of plot is given in figure 8-19. Compare the plotted points with the dashed line indicating the average decay. If the slope of the plotted data is greater than average decay (as is the case with data up to about 15 hours in fig. 8-19), then the predicted intensities and exposures calculated by methods based on average decay will be greater than the actual future intensities and exposures. On the other hand, if the slope of the plotted data is less than the average decay (as is the case with data after about 20 hours in fig. 8-19) then the predicted intensities and exposures calculated by methods based on average decay will be lower than the actual future intensities and exposures. These differences may be significant for planning purposes.

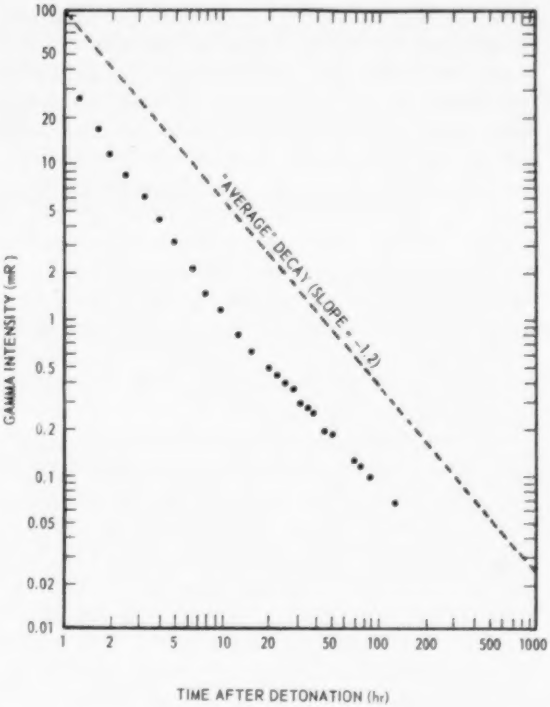

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Figure 8-19.—Gamma decay of fallout sample.

RADIATION-MONITORING AND DECONTAMINATION TEAMS

A radiation-monitoring team will generally precede or accompany a repair party entering a gamma radiation field. Monitors serve as rad-safe support for repair parties. They make sure that appropriate precautions are taken to minimize exposure to gamma radiation and advise as necessary.

A monitoring team should consist of four persons: a monitor, a recorder, a marker and a messenger. The monitoring team will be equipped with a gamma-intensity radiac, a self-reading dosimeter, and materials for tabulating data. The team may be separate from the repair party, or it may be made up of repair party personnel. They will use the radiacs periodically in the course of their work. One monitoring team can probably serve several repair parties working close together.

A radiation monitoring team can accompany decontamination teams for both technical and rad-safe support. It is organized as described previously and would function similarly.

As a part of a radiation monitoring team, you can help a decontamination team operate more efficiently by taking intensity readings of the area being decontaminated, before and after decontamination passes. Be especially careful to take the readings consistently and to inform the decontamination team of the effectiveness of its work. Gamma-intensity measurements are usually sufficient to locate the areas that need decontamination the most. Beta-radiation measurements may be required at hand-operated controls. In this case, use a beta-sensitive radiac.

A decontamination team, supported by a monitoring team, can concentrate on the locations having the highest radiation intensity.

Vary the monitoring technique in support of operations as required to suit the situation. When time is short and gamma-radiation levels are high, you should be concerned primarily with determining whether decontamination is reducing the gamma intensity. You should be taking measurements at the action stations during decontamination; the only measurements of importance are those taken at the actual locations to be occupied by personnel assigned to the stations. You should periodically note the improvement resulting from decontamination. Inform the decontamination crews when further decontamination appears impractical or when the acceptable intensity level has been reached.

After initial decontamination and when radiation levels are low enough so detailed monitoring can be performed without exceeding planning exposure levels, you can locate and identify hot spots for the decontamination crews. You should note the general radiation level in the area and then locate hot spots. Locating hot spots with a radiac requires a detailed technique. Initially hold the radiac at waist height, and read the meter while moving slowly and steadily (so that body motion does not jiggle or sway the instrument's needle). Move side to side, and generally forward, until you determine a direction that gives the higher reading. You can further localize the hot spot by moving in the indicated direction until the radiac is within a few inches of the surface. Hot spots can often be readily suspected by the nature of the material in a given location. For example, cordage, rust, scale, and pools of water are likely to collect contamination.

After decontamination of the assigned area is completed, the monitoring teams should post the general intensity level and the computed maximum safe stay time, based on the planned exposure or the maximum permissible exposure (MPE). Radioactive decay should be ignored. Post this information in a conspicuous place, together with the time the reading was made. Teams should then report the final monitoring data, including the general intensity level.

When time is available and radiation levels are not high enough to be limiting, you can carry out the monitoring survey for either topside or interior decontamination in a detailed manner. Take readings before and after decontamination passes. After a decontamination pass, note the reduction in intensity in their assigned areas. If you find no significant reduction, inform the decontamination crews so that adjustments in the decontamination procedure can be made. After decontamination of the assigned area is completed, note the general intensity level, recheck the hot spots, take and check wipe samples as necessary, and report the final monitoring data. At this time, the monitoring teams should post the general intensity level in a conspicuous place, together with the time at which the reading was made. The safe stay time should also be posted if it is shorter than a normal watch.

SUMMARY

In this chapter, you have been introduced to nuclear bursts, effects, and countermeasures. You will need a good understanding of the radiac instruments since you will use them in the performance of your duties if you are assigned to the radiological monitoring team. When you conduct PMS on the radiac instruments, look them over and review the technical manuals supplied with the instruments. Discuss your repair party CBR assignments with your LPO so that you can relate the information presented in this chapter to your actual assignments. Review the various sections of this chapter as necessary until you are familiar with them. The information presented here may be used when an accident takes place during the handling of nuclear weapons, not just in the event of a nuclear war.

CHAPTER 9

BIOLOGICAL AND CHEMICAL AGENTS

Nuclear weapons are primarily designed to destroy material by blast and shock. Biological and chemical substances for military use are primarily antipersonnel agents; they are intended to produce casualties without the destruction of buildings, ships, or equipment.

This chapter is an overview of shipboard biological warfare (BW) and chemical warfare (CW) defense and countermeasures. Detailed information on this subject is available in *Naval Ships' Technical Manual*, chapter 470.

BIOLOGICAL WARFARE AND CHEMICAL WARFARE COUNTERMEASURES

The BW agents include a variety of microbes and CW agents include poisons. These agents produce temporary incapacitation, sickness, or death in personnel. In tactical use, these agents are generally atomized in the air as aerosols (microscopic airborne solid particles, fine sprays or mists), vapors, or gases. For practical purposes, BW and CW agents in these forms are odorless, colorless, tasteless, and invisible. However, a concentrated spray of aerosol cloud may be temporarily visible when adjacent to an exploded or spraying munition. Also, most BW and CW agents produce no pain or other sensation until physiological damage is well underway. The properties allow an attacker to gain and hold military advantages of surprise and concealment.

The BW and CW agents are entirely different in their detailed effects on the human body, in the medical treatment required, and in their speed of action. However, the Navy has found it useful to consider BW and CW as a single system of toxic warfare for defensive purposes. All BW or CW agents that require the individual to wear both the protective mask and protective clothing fall into the MC (mask and clothing) group. Other BW and CW agents, against which adequate protection is given by the mask alone, are in the MO (mask only) group.

The BW agents are not quick-acting tactical weapons. They are best used for delayed effects against convoys, advanced bases, repair facilities, shipyards, port concentration of ships, task groups at sea, and civilian populations. The CW agents, on the other hand, can be selected for either immediate or delayed action, for brief or prolonged disability, or for temporary physical or mental incapacitation. In general, CW agents are best adapted for quick antipersonnel effects. These agents can be mixed, as can BW agents, to obtain combinations of properties to complicate and confuse the defense.

WEATHER FACTORS

The use of BW or CW agents is dependent upon weather and topography. Calm and low-velocity winds keep the agent clouds concentrated the longest as they move downwind. Gusty and high-velocity winds break up the agent clouds quickly. This makes it difficult to use the winds "to target" units downwind. Precipitation and the vertical temperature gradient in the lower atmosphere significantly affect BW or CW attacks. Heavy and extended rain or snow will gradually wash the air clean of the agents, but short and light precipitation is of little help in cleaning the air.

Normally, the air temperature decreases with an increase in altitude. This rate of temperature decrease is known as the temperature gradient. When the temperature decreases 5.5 °F per 1,000 feet of altitude in dry air or 2.8 °F per 1,000 feet of altitude in saturated air, the gradient is neutral, and a neutral stability condition prevails. Neutral stability is prompted by overcast skies and a sea-surface temperature equal to the air temperature. With a neutral gradient, BW and CW agents will hang suspended with essentially no rising or falling. When the temperature gradient is larger than the figures given above, the air becomes unstable. A sea surface that is warmer than air, the presence of a cold air mass, and bright sunlight all contribute to atmospheric instability. Agents tend to rise continuously in unstable air. The atmosphere increases in stability as the temperature gradient decreases. In a temperature inversion, the atmosphere is extremely stable. It results from a sea-surface temperature that is cooler than the air. Mixing of the lower atmosphere in this condition is produced only by strong winds. The agents tend to move with very little vertical spread.

SHIPBOARD VENTILATION CONTROL

All Navy ships, with the exception of submarines, are continuously ventilated with weather air to some degree under all present material conditions and degrees of closure. Theory and practical tests show there is no "gastight envelope" on any type of United States Navy ship.

Ventilation rates are expressed as rates of change (R of C). An average R of C for spaces in which little heat is generated is about 3 minutes per change. The R of C for air-conditioned spaces is about 20 to 30 minutes per change, although the air within the air-conditioned compartment is recirculated over cooling coils at a much higher rate.

In material condition Zebra, with X-ray, Yoke, and circle William fittings closed, all nonessential fans and blowers are secured. The ship is expected to be in a satisfactory condition of watertight integrity. However, it is not gastight. Air leakage in a closed-up ship is caused by the following:

- Ventilation ducts without closures

- Structural leaks (such as defective welds, aluminum-to-steel joints, and stuffing boxes)

- Bypass leaks through doors, hatches, portholes, and closures due to worn gaskets

- Very large leaks from violations of condition Zebra and unauthorized opening of doors

The rate of increase, or buildup, of outside contamination in a ventilated compartment follows an exponential growth rule. When a ship enters a BW or CW zone, the concentration of contamination in the compartment air increases very rapidly at first and then more slowly as it approaches the concentration of the outside air. As soon as the ship passes out of BW or CW contaminated air, the concentration of the contaminant in the compartment air begins to decrease or decay. The rate of decay follows the same exponential rule as for buildup; there is a fast decrease at first, but it gradually decreases as the compartment contamination level approaches zero.

NOTE: One air change will produce a concentration equal to 63% of the external concentration; three air changes, 95%; and six air changes, 99.8%.

The most favorable ventilation control in a BW or CW situation is ventilation at the lowest practical rate while the ship is in the contaminated zone (interior concentration buildup phase). This is followed by the highest practical rate in clean air (interior concentration decay phase). If the ship is in the contaminated zone for six or more air changes, the compartment dosage will approach the topside dosage, but cannot exceed it.

The least favorable ventilation control in a BW or CW situation is ventilation at a high rate while the ship is in the contaminated zone, followed by a low rate as the ship enters clean air. Under these conditions, the compartment dosage may reach several times the topside dosage.

The situations described above are considered possible but difficult to achieve in practice. They presume (1) exact knowledge of the time of entering and leaving the contaminated zone or (2) the chance increase or decrease of ventilation rate just when the ship leaves the contaminated zone.

A more probable situation is that the ship transits a contaminated zone with no knowledge of the presence of a contaminant. Assuming an unchanging ventilation rate, compartment dosages will be approximately equal to topside dosages.

A thorough indoctrination, full intelligence data, and alert observation will offer you some clues to the existence of contaminated zones. These clues should be considered together with the other elements of the tactical situation. They can then be applied to the best advantage by minimizing ventilation rates during the period of suspected exposure to contaminated air and maximizing ventilation rates for a period of 6 to 12 air changes in clean air.

When there is a possibility of BW exposure, you should consider the effect of sunlight. Airborne microbes live longer when there is little or no light. Therefore, ventilation should be kept to the minimum during the hours of little or no sunlight. The safest period to increase ventilation is between midmorning and midafternoon.

COUNTERMEASURES AT SEA

BW and CW countermeasures are effective only if they are started in time. There is usually a very short time between an indication of an attack and exposure. Often, there is not enough time to take protective measures or to give first aid before personnel topside receive serious or lethal exposure.

For these reasons, topside personnel must be trained and drilled frequently to wear protective clothing and masks when there is a possibility of a BW or CW attack. Inexperienced personnel are handicapped in combat operations while wearing protective gear. The experience they gain from frequent drills will help overcome these handicaps and increase their efficiency.

It is also easier and quicker to protect the ship's structure from contamination than to decontaminate after an attack. There are two kinds of ship protective actions—washdown and closure.

The washdown system protects the ship with a moving film of water. This film is effective only as it washes over the surfaces of the ship; it is not effective while the spray is in the air. As in the protection of personnel, prompt action is the key to effectiveness. Drops and sprays of CW agents cannot lodge easily on a wet ship, and a washdown shield washes them into the sea. If these same sprays or drops fall on a dry ship, they are only partially removed by a washdown. The remainder soaks into the paint and is removed slowly by evaporation.

The closure system protects the interior of the ship against the entry of aerosols and gases. Quick action on closure is essential. It is not possible to predict the results if the ship is closed after exposure; personnel below decks may be in even greater danger from agents trapped inside before closure.

SHIPBOARD BW AND CW DEFENSE SYSTEM

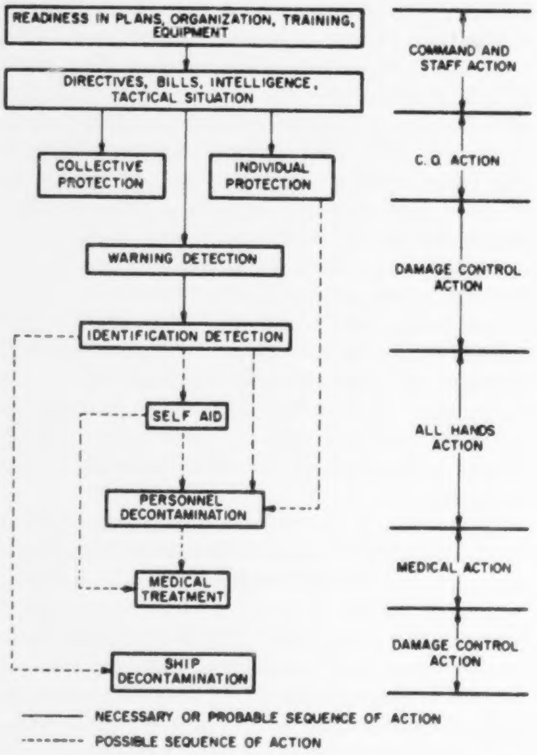
The shipboard BW and CW defense system consists of the following items and procedures:

- Protective mask
- Impregnated clothing
- British Mk III CBR protective clothing
- Wet-weather clothing
- Interior decontamination
- Topside decontamination
- Decontamination of clothing, masks, food, and water
- Personnel decontamination
- Detection
- Self-aid and first aid

The shipboard defense system is shown in figure 9-1.

BIOLOGICAL OPERATIONS

Biological operations are the use of living agents such as bacteria, viruses, and other pathogenic microorganisms to produce disease or death of humans, animals, or plants.


READINESS IN PLANS, ORGANIZATION, TRAINING, EQUIPMENT
DIRECTIVES, BILLS, INTELLIGENCE, TACTICAL SITUATION
COLLECTIVE PROTECTION
INDIVIDUAL PROTECTION
WARNING DETECTION
IDENTIFICATION DETECTION
SELF AID
PERSONNEL DECONTAMINATION
MEDICAL TREATMENT
SHIP DECONTAMINATION
COMMAND AND STAFF ACTION
C. O. ACTION
DAMAGE CONTROL ACTION
ALL HANDS ACTION
MEDICAL ACTION
DAMAGE CONTROL ACTION
NECESSARY OR PROBABLE SEQUENCE OF ACTION
POSSIBLE SEQUENCE OF ACTION

188.42

Figure 9-1.—The shipboard BW/CW defense system.

Biological agents are a threat that must be recognized and prepared for by all personnel. A large part of the defense against biological agents depends upon self-protection and the ability to carry out duties in the presence of such agents.

TYPES OF BW AGENTS

Although biology deals with all living organisms, we are concerned here with military biology, which is only those organisms that will adversely affect man, animals, or plants. These organisms include the following:

- Microorganisms (bacteria, viruses, rickettsiae, fungi, protozoa)
- Vectors of disease (insects, acarids, such as ticks and mites, and animals)
- Pests (of animals and plants)

Microorganisms

Microorganisms are minute living organisms, which can usually be seen only with the aid of a microscope. Each organism is composed of a single cell or a group of associated cells capable of carrying on all functions of life, including growth and reproduction. Microorganisms do not have a digestive tract, organs of sight, or a heat-regulating system. Many of them resemble plant life and are regarded as being in the vegetable kingdom. Some microorganisms, such as the protozoa, have characteristics that place them in the animal kingdom.

Microorganisms are universally distributed in the air, water, and soil. Every cubic foot of topsoil provides a natural home for billions of soil organisms. The skin, hair, nose, mouth, and digestive tract of humans and other animals harbor a considerable variety of microbes in large numbers.

Microorganisms capable of producing disease are known as pathogens. Most of these pathogens are parasites and live on or within another living organism, called a host, which provides shelter and nourishment. Other microorganisms thrive on decaying or dead organic material, and are known as saprophytes. Most microorganisms are nonpathogenic; that is, they do not cause disease. In fact, many of them are beneficial to both man and plant life. Certain microorganisms are responsible for producing many antibiotics, such as penicillin and streptomycin. Others are important in the production of alcoholic beverages, manufacture of vinegar, leather making, and curing cheese and tobacco, as well as in the preparation of industrial solvents.

On the basis of structural and behavioral characteristics, microorganisms are divided into five distinct kinds:

- Bacteria
- Rickettsiae
- Viruses
- Fungi
- Protozoa

These broad groups provide the following agents used in biological warfare.

BACTERIA are very small single-cell organisms. They may be spherical, rod-shaped, or spiral in form. They are visible through an ordinary microscope. They are present everywhere in nature, in air, soil, water, and animal and plant bodies, both living and dead. Many types of bacteria can cause infection. The powerful toxins produced by some could be used alone for biological warfare. (Toxins are discussed later in this chapter.)

Examples of diseases caused by bacteria are typhoid fever, meningitis, and tuberculosis.

RICKETTSIAE are usually smaller than bacteria, but they are still visible through an ordinary microscope. They grow only within living cells, and they are potent disease producers in man and animals. Many of them are transmitted by insect bites. Examples of diseases caused by rickettsiae are Rocky Mountain spotted fever and typhus.

VIRUSES are even smaller than rickettsiae and are not visible with the ordinary microscope. Some have been photographed through the electron microscope. Like the rickettsiae, they will grow only within the living cell. Viruses and rickettsiae are probably less well distributed than bacteria because they are more particular in their growth requirements. However, it is known that they can survive for short periods of time in the air. Examples of virus diseases are mumps, smallpox, psittacosis (parrot fever), and influenza.

FUNGI include such plants as yeasts, molds, and mildews. These organisms are known for their ability to spoil foods and fabrics. Generally speaking, diseases caused by fungi in humans are less severe than those produced by other microorganisms. They usually produce low-grade, mild, and often chronic diseases. A few fungi are capable of producing serious diseases, such as blastomycosis (a chronic infection affecting the skin or the lungs, bones, liver, spleen, and kidneys). Several diseases of plants are caused by fungi. Examples are potato blight, cotton root rot, corn smut, and wheat rust. If an attack is made on food crops, the agents used might be in this class.

PROTOZOA are single-celled, animal-like forms that occur in a variety of shapes and often have complicated life cycles. Some protozoa cause diseases in both man and animals. Problems of production and transmission limit their application in biological warfare, but it must not be assumed that these problems could not be solved. Examples of protozoa infections of man are amoebic dysentery and malaria.

Vectors of Disease

Disease vectors are animal carriers that transfer infective agents from one host to another. They usually are arthropods (insects, arachnids, crustaceans) but may be other animals. They can be classified into two types—biological and mechanical. Biological vectors are animals in whose bodies the infecting organism develops or multiplies before it can infect the recipient animal. Mechanical vectors are animals that transmit infective organisms from one host to another but, in themselves, are not essential to the life cycle of the parasite.

Mosquitoes that transmit malaria and yellow fever are biological vectors. The black horsefly, which transmits anthrax, and many insects that transmit plant diseases are mechanical vectors. Higher animals, and man himself, sometimes act as vectors. Swine are host to trichine, which produces trichinosis in man when he eats inadequately cooked, infected pork. Dogs, cats, skunks, foxes, and some other animals transmit rabies.

Pests

The meaning of the term *pest* as used here is restricted to certain animals (excluding microorganisms) that interfere with the health of other organisms. These pests live on or within the animals, or they are associated with them in other injurious ways. Pests are known as parasites when they obtain their food from living host cells. The presence of a large number of parasites on the surface of the host's body, producing only mechanical effects, is known as infestation. Invasion of the tissues of the body of the host by parasites, producing injury followed by host reaction, is known as infection. Living organisms that consume or destroy food, clothing, and forest products also are characterized as pests.

Although many insects are beneficial to agriculture, great losses are caused by plant-feeding insects and by insect-borne plant diseases. Other serious losses result from the destruction of stored food, clothing, and forest products by such pests as rats and moths. Some pests affecting the animal kingdom are mites, ticks, spiders, scorpions, chiggers, lice, bedbugs, and flies. Some pests affecting plants are the Japanese beetle, snails, corn earworm, boll weevil, and the elm leaf beetle. Other pests that take their toll of man's products and have potential value as BW agents are rats, mice, groundhogs, starlings, and crows.

EFFECTS OF BIOLOGICAL AGENTS

Biological agents may be selected to produce various strategic or tactical goals. These goals range from brief but crippling diseases to widespread serious illnesses with many deaths. The effects of biological agents vary widely, depending upon the agent or agents selected.

The mere presence of a disease-producing organism on or in the body of a host does not guarantee infection or illness. In fact, pathogenic organisms are frequently present and cause no harm in the human body for long periods of time. The factors that determine whether infection will result from contact between a pathogen and a host are not completely understood, but the following are known to be important:

- The general state of health of the individual
- The immunity of the particular individual to the particular organism
- The number of organisms to which the individual is exposed
- The ability of the organisms to cause disease

Remember that the effects of pathogens are always delayed. There is always an incubation period between the time organisms enter the body and the time that symptoms of disease are observed. This period may vary from several hours to several weeks.

To some extent, the effects of pathogens are determined by the route that the infecting organisms use to enter the body. Many organisms require a specific portal of entry to produce infection or disease. Other organisms can cause disease when they enter by any route. The usual ways in which pathogenic organisms enter the body are by inhalation, by swallowing, by direct contact, and by injection. Injection includes insect and animal bites.

DISSEMINATION OF BW AGENTS

Biological agents may be spread in various ways. They may be used as fillings in bombs, shells, or aerial or surface spray tanks. Biological agents may be released from munitions such as aerosols. The aerosols are cloudlike formations of solid or liquid particles in which the biological agents are held suspended.

DETECTION OF BW AGENTS

There are no simple and rapid methods to detect biological agents such as those used to detect chemical agents and nuclear radiation.

The positive detection and identification of a pathogen can be obtained only by taking samples of the organizms, growing a culture of the organisms under laboratory conditions, and then subjecting the culture to a variety of biochemical and biological tests. Obviously, the final identification of pathogens is a problem for medical personnel.

CHEMICAL OPERATIONS

In chemical operations, death, injury, or irritating effects are produced by toxic chemical agents. Although chemical agents are frequently referred to as gases, they may actually be found as solid particles, liquids, or gases. Chemical agents are used chiefly for their effects on personnel. Some agents have corrosive effects on certain materials, and incendiary agents will burn most materials. Chemical agents produce harmful physiological reactions when applied to the body externally, inhaled, or swallowed. Most military chemical agents cause disorganization of the functioning of the body.

Chemical agents can be disseminated by aircraft spray, chemical projectiles, chemical bombs, chemical grenades, smoke pots, smoke candles, chemical land mines, and missiles. These principal factors determine the method by which a chemical agent is spread, the quantity of the agent required to accomplish specific objectives, the nature of the agent being used, the distance to the place of attack, and the speed with which the agent must be used.

CHARACTERISTICS AND EFFECTS OF CHEMICAL AGENTS

A few of the general physiological effects of the more common chemical agents are discussed here and are listed in table 9-1. More detailed physiological effects of the different groups of agents are discussed later.

The rate of action of a chemical agent is the rate at which a body reacts to or is affected by that agent. There is a wide variation in the rate of reaction to the toxic chemical agents, even to those of similar tactical or physiological classifications. For example, distilled mustard (HD) produces no immediate sensation, and 4 to 6 hours may pass before the skin reddens. Lewisite (L), on the other hand, causes immediate pain, and the skin begins to redden within 30 minutes.

Blister agents must be decontaminated within 1 to 2 minutes after exposure if serious effects are to be prevented. Nerve agents and blood agents act quickly. If death is to be averted, you should administer antidotes or start other first aid measures within 30 seconds after the beginning of symptoms. Vomiting and tear agents also take effect within a short time after being inhaled.

Some agents are effective when absorbed through the skin or eyes, but others must be inhaled. Tear agent CN primarily affects the eyes; tear agent CS affects both the eyes and the upper respiratory tract. Blister agents affect the internal as well as the external body surfaces. Nerve agents can attack the body through contact with the skin and eyes and through inhalation. Vomiting agent adamsite (DM) and choking agent phosgene (CG) must enter the lungs to produce their effects.

The rate of detoxification is the rate at which the body counteracts the effects of a chemical agent. It is an important factor in determining the hazards of repeated exposure to sublethal doses of toxic chemical agents. Some agents are detoxified quite rapidly. Other agents are detoxified very slowly, and their effects are cumulative. The blood agents cyanogen chloride (CK) and

Table 9-1.—Properties of Chemical Agents

AGENTS	CHEMICAL AGENT SYMBOL	STATE AT 20°C	ODOR	RATE OF ACTION	PHYSIO-LOGICAL ACTION	PROTECTION REQUIRED	DECON-TAMINATION	MEANS OF DETECTION	USE	PERSISTENCY
CHOKING AGENTS	Phosgene CG	Colorless gas	New-mown hay; green corn	Immediate to 3 hours, depending upon concentration	Damages lungs	Protective mask	None needed; aeration in closed spaces	M18A2	Delayed action casualty agent	Short, however, vapor may persist for some time in low places under calm or light winds and stable atmospheric conditions (Inversion).
	Diphosgene DP	Colorless liquid	New-mown hay; green corn	Immediate to 3 hours, depending upon concentration	Damages lungs	Protective mask	None needed; aeration in closed spaces	M18A2	Delayed action casualty agent	
	Chlorine CL	Yellow gas	Chlorine	Immediate	Damages lungs	Protective mask	M258A1. Soap and water	M18A2	Quick-action casualty agent	
NERVE AGENTS	Tabun GA	Colorless to brown liquid	Faintly fruity; none when pure	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	M258A1. Bleach slurry, steam in confined area	M18A2 and M256 Kits, CWDD	Quick-action casualty agent	Depends upon munitions used and weather. Heavily splashed liquid persists 1 to 2 days under average weather conditions.
	Sarin GB	Colorless liquid	Almost none when pure	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	M258A1. In confined area steam; hot soapy water	M18A2 and M256 Kits, CWDD	Quick-action casualty agent	Evaporates at about the same rate as water. Depends upon munitions used and the weather.
	Soman GD	Colorless liquid	Fruity; camphor odor when pure	Very rapid	Cessation of breath and death may follow	Protective mask and clothing	M258A1. Hot soapy water	M18A2 and M256 Kits, CWDD	Quick-action casualty agents	Depends upon the munitions used and the weather. Heavily splashed liquid persists 1 to 2 days under average weather conditions.
	VX	Colorless liquid	Odorless	Rapid	Produces casualties when inhaled or absorbed	Protective mask and clothing	M258A1. Hot soapy water	M18A2 and M256 Kits CWDD	Quick-action casualty agent	
BLOOD AGENTS	Cyanogen chloride CK	Colorless gas	Somewhat like AC;	Rapid	Interferes with use of oxygen by body tissues	Protective mask	None needed	M18A2 and M256 Kits	Quick-action casualty agent	Short, vapor may persist in jungle or forest for some time under suitable weather conditions.
	Hydrogen cyanide AC	Colorless gas or liquid	Bitter almonds	Very rapid	Interferes with use of oxygen by body tissues	Protective mask	None needed	M18A2 and M256 Kits	Quick-action casualty agent	Short; the agent is highly volatile and in the gaseous state it dissipates quickly in the air.

Table 9-1.—Properties of Chemical Agents—Continued

AGENTS	CHEMICAL AGENT SYMBOL	STATE AT 20°C	ODOR	RATE OF ACTION	PHYSIO-LOGICAL ACTION	PROTECTION REQUIRED	DECON-TAMINATION	MEANS OF DETECTION	USE	PERSISTENCY
BLISTER AGENTS	Distilled mustard HD	Colorless to pale yellow liquid	Garlic	Delayed; hours to days	Blisters; destroys tissues; injures blood vessels	Protective mask and clothing	Bleach	M18A2 and M256 Kits	Delayed-action casualty agent	Depends upon munition used and the weather. Heavily splashed liquid persists 1 to 2 days in concentrations to provide casualties of military significance under average weather conditions, and a week to months under very cold conditions.
	Nitrogen mustard HN-1	Dark liquid	Fishy or musty	Skin effects delayed 12 hours or longer	Blisters; affects respiratory tract; destroys tissues; injures blood vessels	Protective mask and clothing	Bleach	M18A2 and M256 Kits	Delayed-action casualty agent	Depends on munitions used and the weather. Somewhat shorter than duration of effectiveness for HD.
	Nitrogen mustard HN-2	Dark liquid	Soapy in low concentrations, fruity in high concentrations	Serious effects same for HD; minor effects sooner	Similar to HD. Bronchopneumonia may occur after 24 hours	Protective mask and clothing	Bleach	M182A and M256 Kits	Delayed-action casualty agent	
	Nitrogen mustard HN-3	Dark liquid	None if pure	Immediate effects on contact	Similar to HN-2	Protective mask and clothing	Bleach	M182A and M256 Kits	Delayed-action casualty agent	Considerably longer than for HD.
	Phosgene oxime dichloro-foroxime CX	Colorless solid or liquid	Sharp; penetrating	Rapid	Violently irritates mucous membrane of eyes and nose; forms welts rapidly	Protective mask and clothing	None entirely effective	M18A2 and M256 Kits		Somewhat shorter than for HD. Very short duration under humid conditions.
	Lewisite L	Dark oily liquid	Variable; may resemble geraniums	Prompt eye stinging; delayed blistering	Similar to HD plus may cause systemic poisoning	Protective mask and clothing	Bleach	M18A2 and M256 Kits	Moderately delayed casualty agent	
	Mustard-lewisite mixture HL	Dark oily liquid	Garlic like	Immediate eye effect; skin effects 1/2 to 1 hour	Similar to HD plus may cause systemic poisoning	Protective mask and clothing	Bleach	M18A1 Kits, M256	Delayed-action casualty agent	Depends on munitions used and the weather. Somewhat shorter than that of HD.

hydrogen cyanide (AC) are detoxified rapidly, thus requiring high concentration for maximum casualties. The nerve agent sarin (GB) is detoxified slowly and is cumulative to a large degree. If 50% of a lethal dose is received, only minor symptoms appear. However, another 50% received within the next few hours may cause death if no treatment is received. The blister agent distilled mustard (HD) and the choking agent phosgene (CG) also are cumulative. A 10-minute exposure to either followed a few hours later by a similar exposure has the same effect as one 20-minute exposure. Additionally, repeated exposure to sublethal doses of HD can result in sensitivity to low concentrations of the agent.

Nerve Agents

Nerve agents are not quickly and easily detected. Small quantities can quickly cause casualties and deaths. They may be colorless gases with little or no odor or colorless to light brown liquids. These agents radically disturb the chemical processes of the nervous system, which impairs or stops other bodily functions.

Nerve agents can enter the body by inhalation, ingestion, and absorption through the skin and eyes. Entry through the skin is extremely effective. This means that the protective mask alone is not adequate protection because the agent can enter through any exposed skin.

There are now two series or groups of nerve agents—the G series and the V series. The G series is composed of the following agents: tabun (GA), sarin (GB), and soman (GD); the V series is composed of agent VX.

The physical properties of the G agents are similar. The GA is a colorless to brownish liquid, which gives off a colorless vapor; GB and GD are both colorless to light brown liquids, which give off colorless vapors. All three G agents normally are nonpersistent, however, GA and GD are longer lived than GB. G agent poisoning displays approximately the same sequence of symptoms whether the agent enters the body by inhalation, absorption or ingestion. These symptoms, in usual order of appearance, are runny nose; tightness of chest; dimness of vision and pinpointing of the eye pupils; difficulty in breathing; drooling and excessive sweating; nausea; vomiting, cramps and involuntary defecation and urination; twitching, jerking and staggering; and headache, confusion, drowsiness, coma, and convulsion. All of these symptoms can take place in 30 seconds if the dose is sufficiently heavy. These symptoms are followed by cessation of breathing, then death. Symptoms appear much more slowly from skin dosage than from respiratory dosage. Although skin absorption great enough to cause death may occur in 1 to 2 minutes, death may be delayed for 1 to 2 hours. Respiratory lethal dosages kill in 1 to 10 minutes, and liquid in the eyes kills almost as rapidly. The number and severity of symptoms that appear depend on the quantity and rate of entry of the nerve agent into the body.

Most of the detailed information about agent VX is classified and cannot be covered in this text. In general, V agents are colorless and odorless liquids that do not evaporate rapidly or freeze at very low temperatures. Because of their low volatility, their vapor effect is limited; thus, the duration of their effectiveness is increased. In liquid or aerosol form, V agents affect the body in a manner similar to that of the G agents. The V agents usually are disseminated as liquid droplets. When inhaled, these agents are inherently about five times as toxic as the older nerve agents (G series). When absorbed through the skin, the V series agents are several hundred times more toxic than the G agents, because there is no breakdown of the V agent (as there is in GB) as it passes through the fatty layer of the skin.

Blister Agents

The blister agents, used for casualty effect, may restrict the use of ground personnel, slow troop movements, and hamper the use of material or installations. These agents affect the eyes and lungs and blister the skin, producing long-term incapacitation or death. Blister agents are odorless and vary in duration of effectiveness. Most blister agents are insidious in action; there is little or no pain at the time of exposure (except to lewisite (L) and phosgene oxime (CX), which cause immediate pain on contact). The development of casualties is somewhat delayed; the effects of distilled mustard (HD) may appear in 4 to 6 hours after exposure. The first effect is eye irritation. Next, the more sensitive body parts are affected. A series of symptoms follow, ranging from slight redness to blistering and the forming of ulcers. Wet skin absorbs more mustard than dry skin. For this reason, lower concentrations of mustard HD are needed in hot, humid weather because the body is then moist with perspiration. This fact is important in the tropics. Protection from blister agents is extremely difficult, because they attack any part of the body that comes in contact with the liquid or vapor agent.

The primary blister agents, HD and HN, are most effective for general use. However, they are far less effective than the nerve agents for casualties that result in quick death from inhalation, because a high dosage of mustard vapor is required to produce death. Mustard is effective by absorption of both vapor and liquid through the skin. The physiological action is localized to the area of the skin that is contaminated, but it does not produce a systemic effect.

In the pure state, mustard is a yellowish, oily liquid. Because of its high boiling point, liquid mustard evaporates slowly at normal temperatures; consequently, it remains effective for a considerable length of time after application. In fact, in winter months, HD may produce casualties for several weeks after dissemination. On the other hand, the warm temperatures of summer, assisted by wind and rain, may reduce its capability to days. Almost every shipboard surface or material, except bright metal and glass, absorbs some mustard and retains it more or less persistently. Regardless of weather and wind, no shipboard surface contaminated with mustard should be considered completely free of this agent unless a negative test is obtained with a detector kit.

Because HD can be dissolved by fats, it may be dissolved in foodstuffs and make them poisonous. The action on metal is very slight.

Mustard can be dissolved easily in such commercial solvents as benzene and cleaning fluid, and in motor oils, but it is only slightly soluble in water. On prolonged standing, it reacts with water to produce harmless substances.

The newer blister agents include the nitrogen mustards (HN-1, HN-2, HN-3) and the mixed blister agent (HL). These mixtures do not produce more severe injuries than do other agents alone, but they have a lower freezing point than pure HD.

Blood Agents

Blood agents enter the body through the respiratory tract. They affect bodily functions through action on the enzyme cytochrome oxidase, thus preventing the normal transfer of oxygen from blood to body tissue. Most blood agents act rapidly and are normally nonpersistent. In general, a victim who does not die quickly will recover within a few hours. The most common blood agents are hydrogen cyanide (AC) and cyanogen chloride (CK).

Although AC is one of the most deadly poisons known, it is one of the least effective chemical agents because it evaporates rapidly. The vapors are less dense than air. They do not provide a blanket of the agent, and the poisoning effects do not accumulate as exposure continues. CK deteriorates the chemical canisters in protective masks within a short period of time.

Choking Agents

Choking agents, sometimes called lung irritants, primarily injure the respiratory tract—that is, in the nose, throat, and particularly the lungs, causing pulmonary edema. In extreme cases, membranes swell, lungs become filled with liquid, and death results from lack of oxygen; thus, these agents choke an unprotected man. Fatalities of this type are known as "dry-land drownings."

The two most common choking agents are phosgene (CG) and diphosgene (DP). Use of these agents is rather limited because they react rapidly with water to yield nontoxic hydrolysis products. Their concentrations in air are reduced fairly rapidly by water condensates (rain and fog) and by dense vegetation. Other classes of agents are much more efficient. Unlike the nerve and blister agents, choking agents have no poisonous effect upon foods; they are too readily destroyed.

Vomiting Agents

The most important agents of this type are diphenylchlorarsine (DA), diphenylchanoarsine (DC), and adamsite (DM). These agents are dispersed as aerosols and produce their effects by inhalation. Some minor eye irritation also might be observed.

These agents produce a feeling of pain and sense of fullness in the nose and sinuses. This is accompanied by a severe headache, intense burning in the throat, tightness and pain in the chest, irritation of the eyes and lacrimation. Coughing is uncontrollable and sneezing is violent and persistent. Nausea and vomiting are prominent. Mild symptoms, caused by exposure to very low concentrations, resemble those of a severe cold. The onset of symptoms may be delayed for several minutes after initial exposure, especially with DM. Therefore, effective exposure may occur before the presence of the smoke is suspected. If the protective mask is then put on, symptoms will increase for several minutes, despite adequate protection. As a consequence, the victim may believe the mask to be ineffective, and by removing it cause further exposure. On leaving the scene of the attack, the victim's symptoms subside rather rapidly, and the severe discomfort vanishes after about one-half hour. At high concentrations, effects may last for several hours. Because of their arsenical properties, these agents make foods poisonous.

Tear Agents

Tear agents (also known as riot-control agents) are essentially local irritants, which, in very low concentrations, act primarily on the eyes, causing intense pain and a considerable flow of tears; stinging of warm, moist skin; and irritation of the nose. High concentrations produce irritation of the upper respiratory tract and lungs and cause nausea and vomiting. The agents may be either solids or liquids and may be dispersed in the air as vapors or smokes. Tear agent include CN, CNC, CNB, BBC, and CS. Of these agents, CS is the newest and most effective. It produces immediate effects even in extremely low concentrations. An individual is incapacitated about 20 to 60 seconds after exposure. Effects last 5 to 10 minutes after the affected individual is removed to fresh air. During this time, affected individuals are incapable of effective concerted action. The physiological effects include extreme burning of the eyes accompanied by copious flow of tears; coughing, difficulty in breathing, and chest tightness; involuntary closing of the eyes; and stinging sensation of moist skin. This agent is highly successful in quelling riots. Although personnel exposed to CS may shower as necessary, when CS dust or particles are on the skin, showering should be delayed for 6 hours to prevent stinging and reddening of the skin.

Incapacitating Agents

Incapacitating agents were developed through intensive study and research. They are used to wage and win a war without resorting to the massive killing, enormous destruction of property, and immense monetary cost, as in past wars, which undeniably will characterize any future conflict in which nuclear weapons are used. Incapacitating agents are the latest discovery. Many are still in the research, development, and testing stage; much remains to be learned about them.

Effects of these incapacitating agents are not predictable, and with any person, the effects may even change from dose to dose. During a single exposure, a person's feelings may range from impatience, restlessness, and anxiety to an exuberant sense of happiness. He may suffer from delusions of persecution or grandeur. He may reach a catatonic state where he cannot move voluntarily and will hold any position in which he is placed. In this state, a person may suffer from hallucinations, panic, and make violent outbursts.

An agent of this type is BZ, a slow-acting aerosol. It enters the body by inhalation and interferes with mental processes that control bodily functions.

Although there are many unanswered questions concerning the physiological action of these incapacitating compounds and much research remains to be accomplished, they offer many advantages. Some of these advantages are listed below:

- They are flexible. The effects can be tailored to meet a commander's needs—ranging from drowsiness or mild hallucinations and confusion and lack of physical coordination to hysteria, irresponsibility, or complete withdrawal.

- They are economical. They are far less expensive to produce, pound for pound, than fissionable materials or even some of the more advanced conventional weapons.

- They are not destructive. An enemy nation subdued by the use of incapacitating agents against its armed forces and against its support services will not pose to the victors the mammoth problems of reconstruction and rehabilitation. Factories will remain standing; cities will still be alive.

- They are less injurious. Properly employed, these agents are likely to cause far less loss of life, less maiming or crippling, and less permanent aftereffects than has been true of high explosives used in past conflicts.

- They are a simpler weapons system. Agents of this type are easily stored, loaded into munitions, and delivered on target. They may be projected from generators upwind of the enemy as an aerosol; they may be introduced clandestinely into his food and water supplies; they may be injected, by one well-placed agent, into the ventilating systems of large headquarters.

Table 9-2.—Chemical Agent Detection Capabilities

IDENTIFIER SYMBOLS	TYPE AGENTS	CHEMICAL AGENT NAME	*M8 PAPER	*M9 PAPER	M256	** M18A2	CWDD	CAPD
GA	Nerve	Tabun		X	X	X	X	X
GB	Nerve	Sarin	X	X	X	X	X	X
GD	Nerve	Soman	X	X	X	X	X	X
VX	Nerve	Unknown	X	X	X	X	X	X
AC	Blood	Hydrogen cyanide		X	X	X		
CK	Blood	Cyanogen chloride			X	X		
CX	Blister	Phosgene oxime		X	X	X		
ED	Blister	Ethyldichloroarsine		X	X			
HD	Blister	Distilled mustard	X	X	X			
HL	Blister	Mustard-lewisite mixture	X	X	X			
HN1	Blister	Nitrogen mustard	X	X	X			
HN2	Blister	Nitrogen mustard	X	X	X			
HN3	Blister	Nitrogen mustard	X	X	X			
HT	Blister	Mustard Mixture	X	X	X			
L	Blister	Lewisite	X	X				
MD	Blister	Methyldichloroarsine		X	X			
PD	Blister	Phenyldichloroarsine		X	X			
T2	Nerve							
HT-2	Blood/Blister	Trichothescenes			X			
CG	Choking	Phosgene			X	X		

*Will detect all agents in liquid form only.
**For EOD—May be aboard ship.

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- They are difficult to detect. Most agents of this type are colorless, odorless, tasteless, and produce no immediately recognizable physiological symptoms. Sprays can be made to resemble obscuring smoke; artillery shells can be designed that display the same burst characteristics as HE rounds.

Effective personal protective measures can be adopted with incapacitating agents as with other chemicals—the protective mask, protective clothing, highly sensitive alarms, or detectors.

Toxins

Toxins are poisonous products of animal or vegetable cells. When injected into animals or people, they cause the formation of antibodies called antitoxins. The most important toxins are those produced by bacteria, the most potent of which is botulin. Boutlin is hundreds of times more poisonous than phosgene, mustard gas, or cyanide, and it is several times more toxic than rattlesnake or cobra venom. Toxins can be used in two ways: (1) They can be produced outside the body and introduced into food, water, or wounds, or (2) the organisms producing them can be used as agents. In peacetime, control is exercised over diseases of this group by strict sanitary measures and thorough medical inspection of all foods prescribed by the Food and Drug Administration.

Incendiaries

Incendiary weapons, unlike other chemical agents, are concerned primarily with material damage rather than with inflicting casualties. Incendiaries have been used against personnel. However, their greatest application is in the destruction of industrial installations, housing, ammunition, fuel dumps, and so on.

Modern military incendiaries may be divided into three categories—oil, metal, and a combination of oil and metal. They may also be divided into spontaneously flammable materials, such as phosphorous, and those agents requiring ignition, such as magnesium and thermite.

DETECTION OF TOXIC CHEMICAL AGENTS

It is difficult, and sometimes impossible, to identify chemical agents by sight, smell, or other sensory impressions. This method is quite unreliable, and it can be fatal. Some toxic agents are so deadly and so quick acting that one brief skin contact or one small whiff of vapor can cause immediate death.

Various devices are available to detect and identify chemical agents. Table 9-2 lists various chemical agents and which detection devices may be used to detect the individual agent. Most of these devices indicate the presence of chemical agents by color changes that are chemically produced. Some of the detection devices used in the Navy are discussed in the following sections.

Chemical Agent Detection Paper

Two types of chemical agent detection paper are being used in the Navy at the present time—the M-8 and the M-9. The M-9 paper is relatively new, and it supplements the M-8 paper. The M-9 paper does not replace the M-8 paper. Both types of paper are requisitioned separately through the supply system.

M-8 PAPER.—The M-8 chemical agent detection paper (fig. 9-2) is issued in a book of 25 split sheets (50 separate responses). It is chemically treated, dye impregnated, and perforated for easy removal. This paper detects the

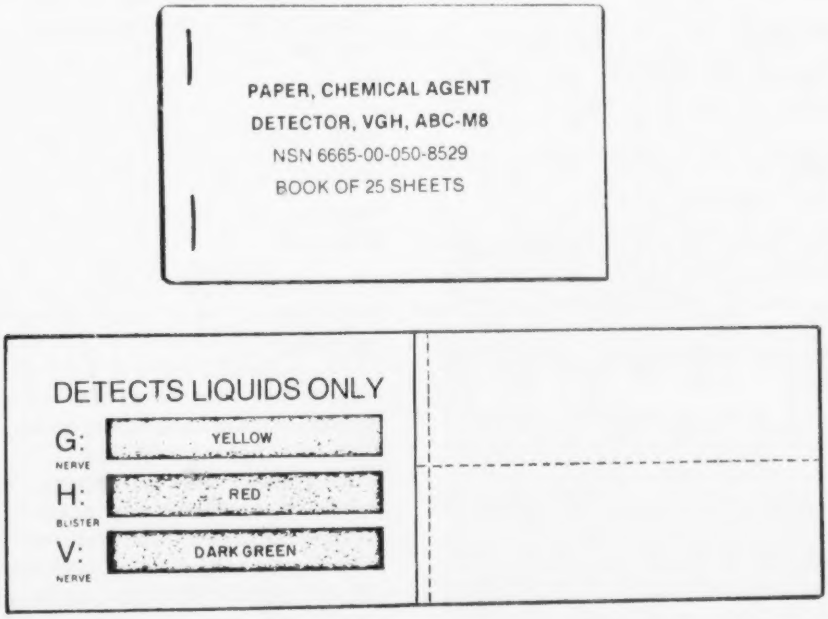

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Figure 9-2.—Paper, chemical agent detector, MB.

Table 9-3.—M-8 Paper Color Comparison Chart

	Agent	Color
Nerve	GB - Sarin	Yellow
	GD - Soman	Yellow-brown
	VX	Blue-black
	VX - 55	Dark green
Blister	HD - Distilled Mustard	Red
	- Lewisite	Scarlet

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presence of liquid V agents, G agents (nerve), and H agents (blister/mustard). When the M-8 paper is brought in contact with the suspected chemical agent, the chemicals in the paper react with the agent to produce specific color changes. The sheet of paper is then matched to the color comparison chart printed on the inside front cover of the M-8 book. The color response for M-8 paper is listed in table 9-3. Liquid droplets as small as 125-200 microns will produce a color change that is detectable by the naked eye. Response time is approximately 20 seconds.

NOTE: Certain agents give a red-brown color response, which is intermediate between the typical H and the typical G colors.

When using the M-8 paper, follow these procedures:

1. Detach a sheet of detector paper from the book and attach it to your clothing, or place it on a surface so that it can be exposed to drops or liquid splash of chemical agents. Use masking tape or any other available means to secure the paper in place.
2. If colored spots appear, put on your protective mask. Be prepared to take proper medical action if symptoms appear.
3. Compare the colored spots with the colors on the inside cover of the detector paper book to determine what type of agent is present.
4. The paper may also be used to detect liquid contamination by placing the paper in contact with the suspect surface. A color change similar to that shown on the inside cover indicates the presence of chemical agents. This paper will NOT detect gases or vapors.

M-9 PAPER.—The new M-9 (fig. 9-3) detector paper detects nerve agents (G and V) and blister agents (H and L) in the liquid state. The paper is sensitive to droplets as small as 100 microns and responds in approximately 10 seconds or less. The response time increases at temperatures below freezing. High temperatures of 160°F or above may cause a red color to appear, thus producing a false reading. The use of the M-9 detector paper is limited to agents in the liquid state; it will not detect chemical agent vapors. The M-9 detector paper has no agent specificity; the red color appears for all detectable agents.

The M-9 liquid agent detector paper is issued by the roll and is 30 feet long and 2 inches wide. It has a Mylar film backing that has adhesive and release paper on the reverse side. The roll comes in a cardboard dispenser that has a serrated metal edge for cutting. A moistureproof, resealable bag is provided for storing the dispenser after it is removed from its original shipping package.

When you open the shipping package (fig. 9-3, view A), remove the dispenser and the plastic storage bag. Save the plastic storage bag and discard the shipping package. Immediately write or stamp the current date on the dispenser. This date will be the base line to determine the useful life of the M-9 detector paper. Remove the cutter edge protector and throw the protector away.

WARNING: The M-9 detector paper dye may cause cancer, but because very little is used, the risk is small. Always wear protective gloves when touching the detector paper. Do NOT place the detector paper in or near your mouth or on your skin.

To remove the M-9 detector paper from the dispenser (fig. 9-3, view B), use the following procedures:

1. Start the olive drab (OD) paper strip through the slot by applying a little finger pressure with the thumb or finger.
2. Hold the detector paper strip between the forefinger and thumb of one hand and the OD paper strip between the forefinger and thumb of the other hand. Pull enough of the detector paper out through the slots for the intended use. (Pull the detector paper strip and the OD paper strip at the same time.)

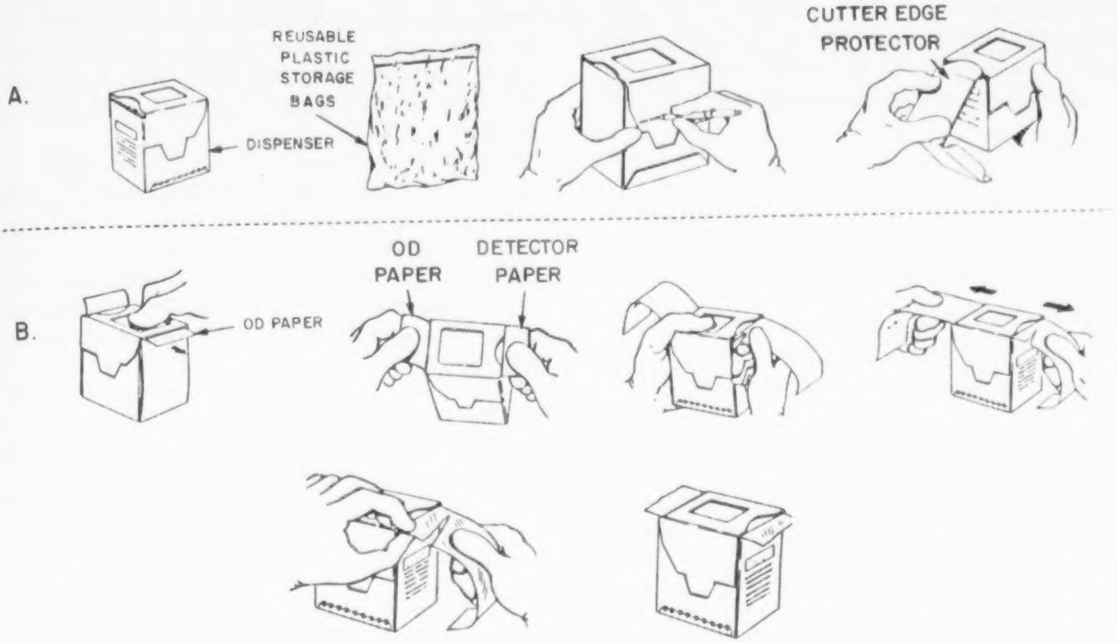

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Figure 9-3.—M-9 chemical agent detector paper.

3. After you pull both of the paper strips through the slots, cut the detector paper half way by pulling the strip down on the cutting edge.

4. Lift the detector paper strip up off the cutting edge, and then pull both of the strips out a little further, about 1 inch.

5. Tear through the remaining half of the detector paper strip.

6. Tear off the OD paper strip, but leave enough paper sticking out to be ready for your next use.

To attach the M-9 detector paper to equipment, use the following procedures:

1. Attach the detector paper to equipment and bulkheads at locations where it can be seen easily. Wrap the detector paper around some part of the equipment where it will not get stepped on. To help make it easier to remove the detector paper, fold 1 inch of the paper back over (adhesive side to adhesive side) to form a tab. Remember to keep the paper away from hot surfaces and direct sunlight. Heat may cause the detector paper to turn red and cause false readings.

2. To attach the detector paper to flat surfaces, place the paper on the surface. Cover the detector paper with the OD paper strip and press the detector paper into place. Be sure to make a tab, as mentioned above, to help make it easy to remove the detector paper when required.

To check the surface of an area for liquid chemical agent contamination, take a piece of the detector paper and blot the surface around the suspected contaminated area. Do not rub or scrape the detector paper across rough surfaces. Scuff marks will cause false readings. If spots on the paper appear pink, red, red-brown, red-purple, or any shade of red, take protective actions and assume that you have been exposed to a liquid chemical agent.

Do not check the detector paper under a red light because you will not be able to see the liquid chemical agent red spots. Personnel who are color-blind should not check the detector paper for red spots. Blue, yellow, green, gray, or black spots are caused by humidity, not by liquid chemical agents.

Detector paper strips that show false positive readings need to be replaced with a fresh strip. False positive readings can be caused by the following factors:

- Temperatures above 125 °F

- Scuffs
- Cleaning compounds
- DS-2 decontaminating agent
- Gasoline
- Grease
- Hydraulic fluid and brake fluid
- Insect repellent/spray
- Lubricating oil
- Ethylene glycol (pure antifreeze)

The detector paper will work in rain, snow, and sleet. However, the reaction to agents is slower when the detector paper is soaked. When the surfaces are wet, attach the detector paper tighter than usual to prevent it from slipping. Temperatures around 32 °F slow down the speed that the paper will turn red. It may take the paper several minutes to show a color change.

When the dispenser is not in use, place it in the plastic storage bag to prevent contamination of the detector paper. Squeeze out the air before sealing the plastic storage bag. If the discard date or the useful life date has passed, replace the detector paper with a new, unopened roll.

M256 Chemical Agent Detector Kit

The M256 chemical agent detector (fig. 9-4) is a portable, expendable item that consists of a carrying case with straps, 12 sampler-detectors, one book of M-8 paper, and a set of operational instruction cards. You will use the sampler-detectors to test for chemical agents in the vapor form. The M-8 paper is used to check for chemical agents in the liquid form.

The 12 sampler-detectors are individually wrapped. Each sampler-detector consists of eight glass ampoules (each filled with chemical reagent), three test spots, a chemical heater, protective strips, and tabs. Each sampler-detector has instructions for its use printed on the outside of its protective bag. Formed channels in the plastic sheets direct the flow of the reagents from the finger-crushable ampoules to wet the test spots at the time of testing. SAFE/DANGER observations are printed on each sampler-detector. They show the approximate color that each spot develops if the agent is present and if it is absent.

To detect mustards (H and HD) and phosgene oxime (CX), the square test spot is used with the blister reagent ampoules and the chemical heater. To detect lewisite (L), the lewisite detecting tablet and the lewisite tablet rubbing tab are used. A pull tab covers the lewisite detecting tablet.

To detect hydrogen cyanide (AC) and cyanogen chloride (CK), the circular test spot is used with the blood reagent ampoules.

To detect nerve agents (V and G), the star-shaped test spot is used with the nerve reagent ampoules.

The hinged protective strip, used in the closed position, protects the blood and nerve agent test spots. The colored beads in the ampoules have no operational function. They are installed during manufacture of the sampler-detector as an aid in identifying the sampler ampoules.

One book of M-8 chemical agent detector paper is also included in the M256 kit. Use the M-8 paper as discussed earlier in the chemical agent detection paper section of this chapter. One set of operational instruction cards is attached to the case by a lanyard. These cards contain instructions on the use of the M256 kit.

The M256 kit is a portable means for CBR monitoring teams to detect concentrations of nerve, blister, or blood agents; to differentiate between classes of agents; and to help determine when it is safe to remove CBR protective masks and clothing. The M256 kit has replaced the M15A2 chemical agent detector kit that was used just a few years ago.

When using the M256 kit to detect vapors in the air, you should use the following procedures:

1. Remove the three operational instruction cards from the kit. Read these instructions before proceeding.

2. Remove a sampler-detector from the kit. Check to ensure that it has not exceeded its discard expiration date. Do not use an outdated sampler-detector because it will not give you a reliable test indication.

3. Read the instructions on both sides of the protective bag before proceeding.

4. Open the sampler-detector bag by tearing the bag along the tear line that is marked with arrows. Hold the sampler-detector on the windward side from you to keep from picking up vapors from your protective equipment. Do not allow excessive moisture, such as rain and dew, to come in contact with the sampler-detector.

5. Carefully remove the sampler-detector from its protective bag. Save the protective bag to refer to the instructions that are printed on it. Do not touch the sampler-detector agent test spots because incorrect test results may be produced.

6. Handle the sampler-detector carefully. Hold it by the hinged protective strip in the closed position. Keep the protective strip in the closed position to protect the test spots.

7. Swing the hinged heater assembly away from the test spot and discard the two loose protective strips under the hinged heater assembly.

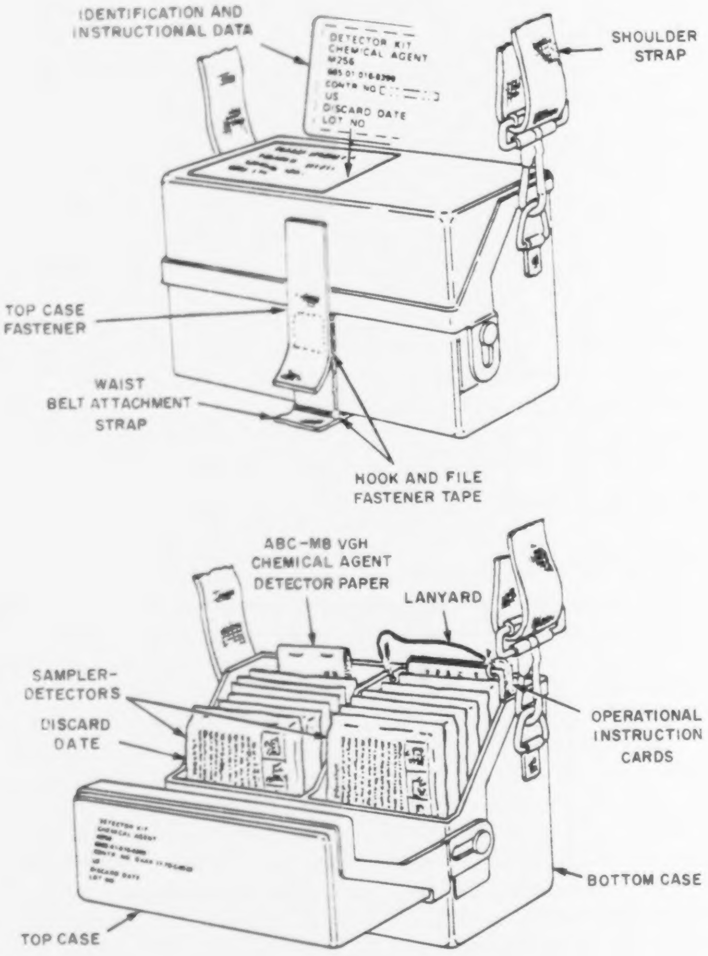
IDENTIFICATION AND INSTRUCTIONAL DATA
DETECTOR KIT CHEMICAL AGENT M256
CONTR NO
US
DISCARD DATE
LOT NO
SHOULDER STRAP
TOP CASE FASTENER
WAIST BELT ATTACHMENT STRAP
HOOK AND FILE FASTENER TAPE
ABC-M8 VGH CHEMICAL AGENT DETECTOR PAPER
LANYARD
SAMPLER-DETECTORS
DISCARD DATE
OPERATIONAL INSTRUCTION CARDS
BOTTOM CASE
TOP CASE

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Figure 9-4.—M256 chemical agent detector kit, front view.

Refer to figure 9-5 as we continue the discussion on the operating procedures for the M256 kit.

8. Pull off and discard the pull tab (marked 1) to expose the lewisite detecting tablet.

9. Rub the top half of the white paper side of the lewisite tablet rubbing tab (marked 2) on the lewisite detecting tablet. Repeat the rubbing until a mark is visible.

10. Hold the sampler-detector in the vertical position so that the ampoules are down.

11. Crush the four reagent ampoules in the three center pockets (marked 3) with your finger.

12. Rotate the sampler-detector until the test spots are in a down position. Force the liquid from the four ampoules through the formed channels to the test spots to ensure wetting.

13. Check to ensure that the hinged protective strip is over the test spots. Hold the

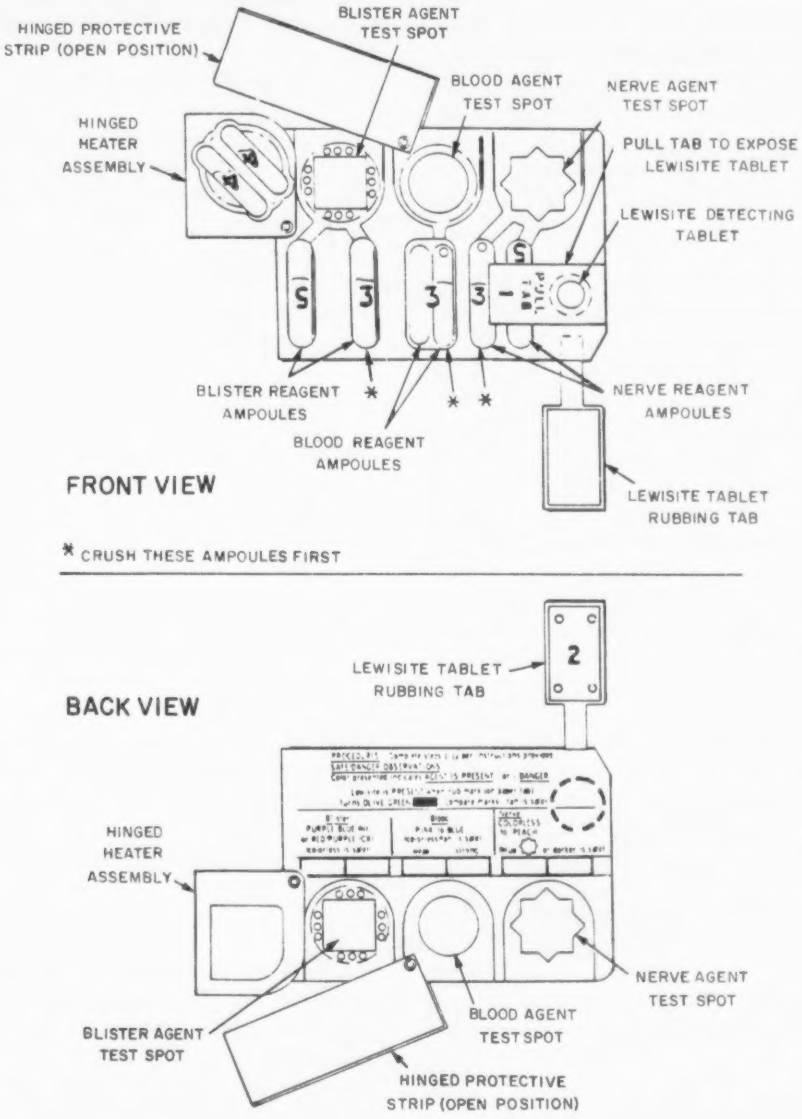
HINGED PROTECTIVE STRIP (OPEN POSITION)
BLISTER AGENT TEST SPOT
BLOOD AGENT TEST SPOT
NERVE AGENT TEST SPOT
HINGED HEATER ASSEMBLY
PULL TAB TO EXPOSE LEWISITE TABLET
LEWISITE DETECTING TABLET
5
3
3
3
1
5
PULL TAB
BLISTER REAGENT AMPOULES
*
* *
NERVE REAGENT AMPOULES
BLOOD REAGENT AMPOULES
FRONT VIEW
LEWISITE TABLET RUBBING TAB
* CRUSH THESE AMPOULES FIRST
LEWISITE TABLET RUBBING TAB
2
BACK VIEW
HINGED HEATER ASSEMBLY
NERVE AGENT TEST SPOT
BLOOD AGENT TEST SPOT
BLISTER AGENT TEST SPOT
HINGED PROTECTIVE STRIP (OPEN POSITION)

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Figure 9-5.—Sampler-detector (protective bag removed).

sampler-detector horizontal with the left thumb over the center test spot.

14. Make sure that the hinged heater assembly is away from the test spot. The heater produces hot vapors and is hot to the touch. Keep the sampler-detector away from your face and bare skin once the ampoules have been broken.

15. Crush one of the two green ampoules (marked 4) with your finger. Immediately swing the hinged heater assembly over the test spot. Vent the vapor away from your body. Leave the hinged heater assembly in place for 2 minutes.

16. Swing the hinged heater assembly and the hinged protective strip away from the test spot after the 2 minutes have passed.

17. Hold the sampler-detector by the hinged protective strip.

18. Expose the test spots to the air for 10 minutes while shielding the sampler-detector from direct sunlight.

19. Crush the second green ampoule (marked 4) with your finger. Swing the hinged heater assembly over the test spot, and vent the vapor away from you. Leave the hinged heater assembly in place for 1 minute.

20. Swing the hinged heater assembly away from the test spot after 1 minute has passed.

21. Hold the sampler-detector vertically with the test spots down.

22. Crush the remaining ampoules (marked 5) with your finger. Force the liquid from the two ampoules through the formed channels to the test spots to ensure wetting.

23. Rerub the lewisite detecting tablet with the lewisite tablet rubbing tab. Make sure that the second rub mark is next to the first rub mark.

24. Immediately turn the sampler-detector over to determine whether safe or danger conditions exist. Observe the lewisite tablet rubbing tab for a difference in color between the two rub marks. Also, you can use the operational instruction cards to make a color comparison.

You can compare the blood agent and the lewisite tests immediately after the prescribed exposure time. The blister agents (H and CX) develop color immediately after all of the ampoules are broken. The nerve agent test requires a waiting period of 2 minutes. Disregard the small, blue areas under the plastic rim of the nerve agent spot. The blue coloring is caused by the humidity. The nerve spot may become difficult to wet with the solutions as the kit ages. You have to work the solutions to the spot carefully. At low concentrations, a change in the lewisite tablet rub mark may be very slight. Compare the first rub mark with the second rub mark before making a judgement. Yellow and orange colors sometimes occur on the blood test spot when no agent is present. A pink or blue color must be present for the test to be positive.

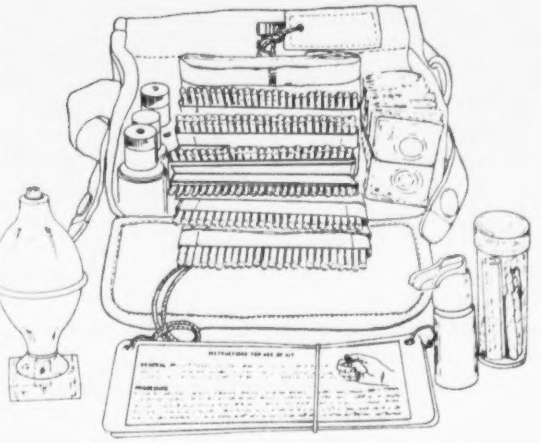

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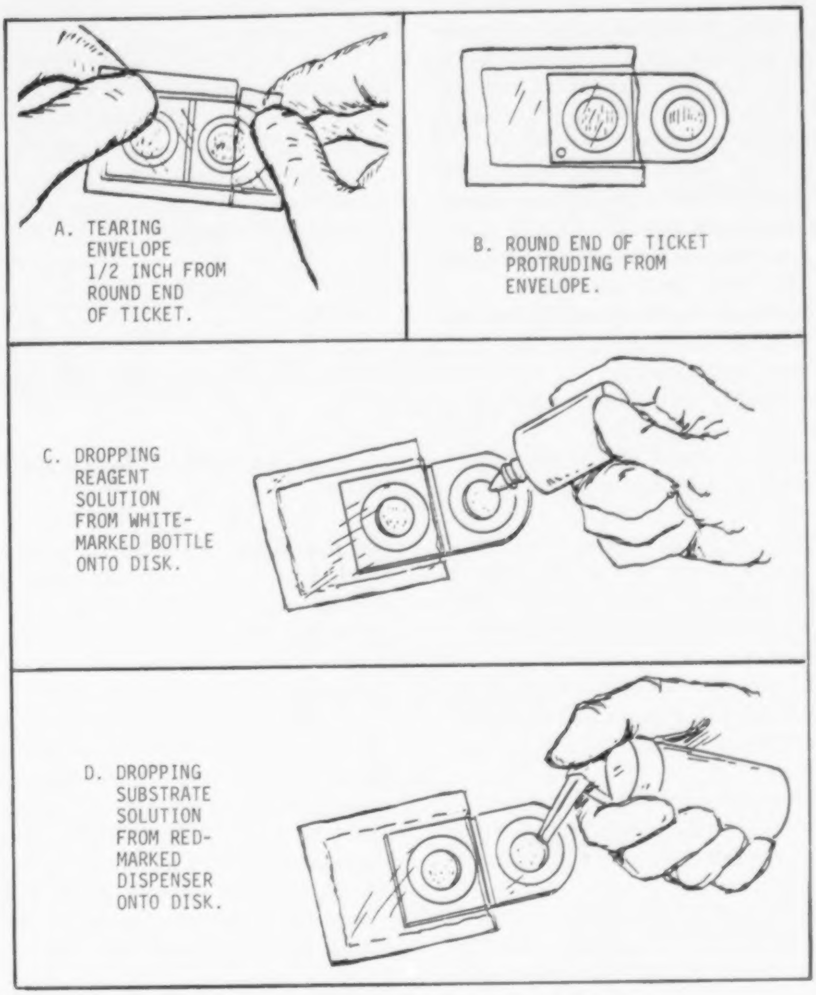
Figure 9-6.—M18A2 chemical agent detector kit.

If the suspected surface contamination is in the form of a liquid, use the M-8 paper as discussed earlier. Keep the M256 kit stored in a cool, dry area when not in use. Be sure that the case is kept closed. Inspect the M256 kit completely before using to make sure you have all of the equipment needed. If any of the components are missing or the blood agent test spot is pinkish, do not use the sampler-detector.

M18A2 Chemical Agent Detector Kit

The M18A2 chemical agent detector kit (fig. 9-6) is used to detect dangerous concentrations of toxic chemical agents in the atmosphere as well as residual surface contamination. The agents that may be detected by this kit are AC, CG, CK, CX, ED, G, H, HD, HN, L, and V. If a toxic agent is suspected but cannot be identified, collect samples of the agent and forward them to an appropriate laboratory for identification. The M18A2 detector kit consists of an aspirator bulb assembly, detector tickets, detector sampling tubes, reagent packets, a substrate dispenser, M-8 detector paper, and some other accessories.

Before using the detector kit, check the detector tickets in the belt as described below. Make this initial check just before each entry to a contaminated area to ensure that the belt is serviceable. All of the tickets used for the initial



A. TEARING ENVELOPE 1/2 INCH FROM ROUND END OF TICKET.

B. ROUND END OF TICKET PROTRUDING FROM ENVELOPE.

C. DROPPING REAGENT SOLUTION FROM WHITE-MARKED BOTTLE ONTO DISK.

D. DROPPING SUBSTRATE SOLUTION FROM RED-MARKED DISPENSER ONTO DISK.

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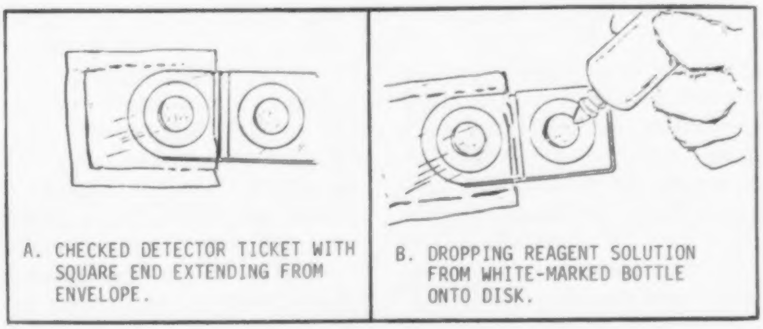
Figure 9-7.—Checking detector ticket before use.



A. CHECKED DETECTOR TICKET WITH SQUARE END EXTENDING FROM ENVELOPE.

B. DROPPING REAGENT SOLUTION FROM WHITE-MARKED BOTTLE ONTO DISK.

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Figure 9-8.—Preparing ticket for use.

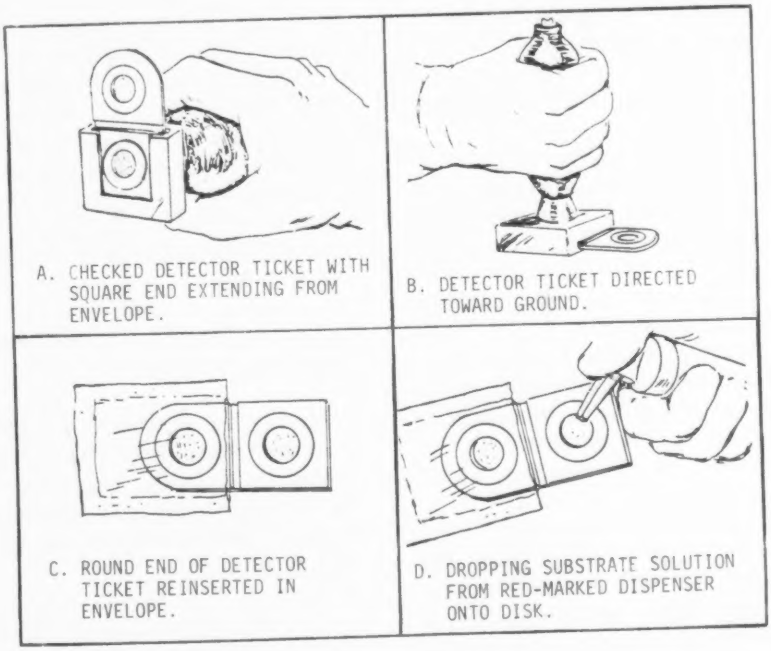
check should be discarded since the ability of these tickets to detect agents may be destroyed. The following procedure for checking detector tickets may differ from that given in the detector instruction cards. However, this procedure is preferred. When reading the following discussion on the initial check procedures, refer to figure 9-7.

1. Detach a plastic envelope containing a detector ticket from the belt of tickets.
2. Tear the envelope approximately one-half inch from the top of the round end of the ticket (view A). The existing notch or small slash in the envelope will assist in making this tear.
3. Push the round end of the ticket out of the envelope (view B).
4. Add two drops of reagent from the white-marked bottle onto the disk (view C). If the disk does not wet easily, insert the ticket into the envelope and massage the round end of the ticket in the envelope until the disk is uniformly wet.
5. Remove the plastic guard from the red-marked substrate dispenser. Push the round end of the ticket out of the envelope if it has been placed back in the envelope. Carefully add two drops of the substrate solution onto the wet disk (view C). If the disk does not turn blue within 3 minutes, insert the ticket into the envelope and massage the ticket. If a blue color does not develop, discard the ticket and obtain a fresh one.

Once the initial check is completed and the belt of tickets has been determined to be serviceable, you will need to prepare the detector ticket for use. This can be done just before you go into a contaminated area, or while you are in a contaminated area. Refer to figure 9-8 as you read the discussion on preparing a detector ticket for use.

1. Detach a plastic envelope containing a detector ticket from the belt of tickets.
2. Tear the envelope approximately one-half inch from the top of the round end of the ticket. The existing notch or small slash in the envelope will assist in this tear.
3. Reverse the ticket in the envelope until the square end is out of the envelope (view A).
4. Place two drops of reagent from the white-marked bottle onto the disk in the square end (view B). If the disk does not wet easily, reinsert the ticket into the envelope and massage the square end of the ticket until the disk is uniformly wet.

Now you are ready to collect and test vapor samples for chemical agents. Refer to figure 9-9


A. CHECKED DETECTOR TICKET WITH SQUARE END EXTENDING FROM ENVELOPE.

B. DETECTOR TICKET DIRECTED TOWARD GROUND.

C. ROUND END OF DETECTOR TICKET REINSERTED IN ENVELOPE.

D. DROPPING SUBSTRATE SOLUTION FROM RED-MARKED DISPENSER ONTO DISK.

Figure 9-9.—Collecting and testing vapor samples for V or G agents.

as you read the following discussion on the collection and testing of vapor samples. Use the following procedures while conducting these tests:

1. Install the square end of a prepared detector ticket in the aspirator bulb adapter with the plastic cross support behind the disk facing toward the bulb (view A).

2. Direct the ticket toward the ground (view B) and compress the bulb 60 times. Allow the bulb to reinflate completely between compressions.

3. Withdraw the ticket from the aspirator bulb adapter and insert the round end of the ticket into the envelope (view C) so that the square end is not covered by the plastic.

4. Carefully add 2 drops of substrate solution onto the disk at the square end of the ticket (view D). Push the ticket all the way into the envelope. Massage the ticket in the envelope.

5. Observe the color of the disk in the square end of the detector ticket. Indication will appear within 3 minutes.

a. If the disk is white or light red-orange, there are V or G agents or a combination of V and G agents in the atmosphere.

b. If the disk is blue, there are no V or G agents present.

c. If most of the disk is white or light red-orange with a fringe of blue, there are very low concentrations of V or G agents.

To test for CK agents, use the following procedures:

1. Snap both ends from a blue-band detector tube at the scorings. Press the unmarked end of the detector tube into the adapter. With the detector tube pointing down, compress the bulb 60 times.

2. Remove the detector tube from the adapter. If a yellow or orange color appears in the detector tube, CK is present. If a CK agent is present, discard the detector tube and omit the test for G agents and the test for mustards or CS.

To test for G agents, use the following procedures:

1. Perform this test only if the CK test is negative (no yellow color) following the detector ticket test. Use the blue-band detector tube from the CK test for this test. White-band detector tubes may be used if there is a shortage of blue-band tubes. However, the white-band detector tubes are NOT to be used to test for other than G agents.

2. Squeeze 1 drop of reagent solution from the green-marked bottle into the banded end of the detector tube. If yellow appears within 1 minute, G agent is present.

To test for mustard or CX vapors, use the following procedures:

1. Perform this test only if the CK test is negative. Use a blue-band detector tube for this test.

2. Snap both ends from the detector tube at the scorings. Press the unmarked end of the tube into the adapter. With the detector tube pointing down, compress the bulb 60 times. Remove the detector tube from the adapter.

3. Wait at least 2 minutes after sampling, then squeeze 1 drop of reagent solution from the blue-marked bottle into the banded end of the detector tube.

4. If the purple-blue ring or color appears, H, HD, HN, or HT is present. If a red-brown ring or color appears, CX is present. (A light-brown color that fades within 15 seconds is not a positive test.)

To test for L, ED, or MD agents, use the following procedures:

1. Use a yellow-band detector tube for this test. Snap both ends from the detector tube at the scorings. Press the unmarked end of the detector tube into the adapter. With the detector tube pointing down, compress the bulb 60 times.

2. Remove the detector tube from the adapter and observe the color. If a blue-green ring or color is observed, ED or a high concentration of L is present.

3. Squeeze 1 drop of reagent solution from the blue-marked bottle into the banded end of the detector tube. If a blue or blue-green ring or color appears, L, ED, or MD (singly or in combination) is present.

To test for CG agents, use the following procedures:

1. Snap both ends from a green-band detector tube at the scorings. Press the unmarked end of the tube into the adapter. With the detector tube pointing down, compress the bulb 60 times.

2. Remove the detector tube from the adapter and observe the color. If a green ring or color appears, CG is present.

To test for AC agents, use the following procedures:

1. Snap both ends from a red-band detector tube at the scorings. Press the unmarked end of the detector tube into the adapter. With the detector tube pointing down, compress the bulb 60 times.

2. Remove the detector tube from the adapter. If a blue ring or color appears in the detector tube, AC is present.

To test for liquid agents (blister and nerve agents) on surfaces, use the M-8 detector paper that is supplied with the kit. Follow the procedures that were discussed earlier when you use the M-8 detector paper.

You may not get a positive reading from the above tests. If this happens and you still suspect that a chemical agent is present, use the following procedures to conduct further checks:

1. Complete a report card. Be sure to record information that may be helpful in determining the nature of the unknown agent. Describe the unit taking the samples; the place, date, and time the samples are taken; observed characteristics of the agent; and the effect of the agent on personnel. List the observed color effects on the various types of detector tubes.

2. Select an area for sampling that is likely to have a high concentration of agent (a depression in the ground or just above a puddle of liquid agent). Take samples in five white-band sampling tubes. The instructions given below apply to each of the five sampling tubes.

a. Snap both ends from a white-band sampling tube at the scoring. Press the unmarked end into the adapter.

b. With the sampling tube pointing down, compress the bulb 60 times.

c. Remove the sampling tube from the adapter and place it in the envelope containing the completed record card.

3. Place the five sampling tubes and the report card in an envelope, seal the envelope, and forward it to the chemical laboratory designated.

The following steps should be used to keep the M18A2 detector kit in a usable condition.

1. Keep the kit dry because it is not waterproof.

2. Inspect the kit for worn or unusable parts. Replace those parts as necessary.

3. Examine the red-band and green-band detector tubes (without regard to detector kit discard date) to determine if they are in usable condition.

a. A red-band tube is in usable condition when the impregnated silica gel is colorless or light pink. Discard red-band tubes when the impregnated silica gel is blue or green. (See instruction cards for color.)

b. A green-band tube is in usable condition when the impregnated silica gel is yellow or light tan. Discard green-band tubes when the impregnated silica gel is brown or green. (See instruction cards for color.)

4. Check the aspirator bulb at least semiannually. Insert the end of a sealed detector tube (end broken) in the aspirator bulb adapter. Compress the bulb, holding the valve end up. The bulb should require at least 10 seconds to reinflate after the bulb has been released. If the bulb reinflates in less than 10 seconds, it leaks.

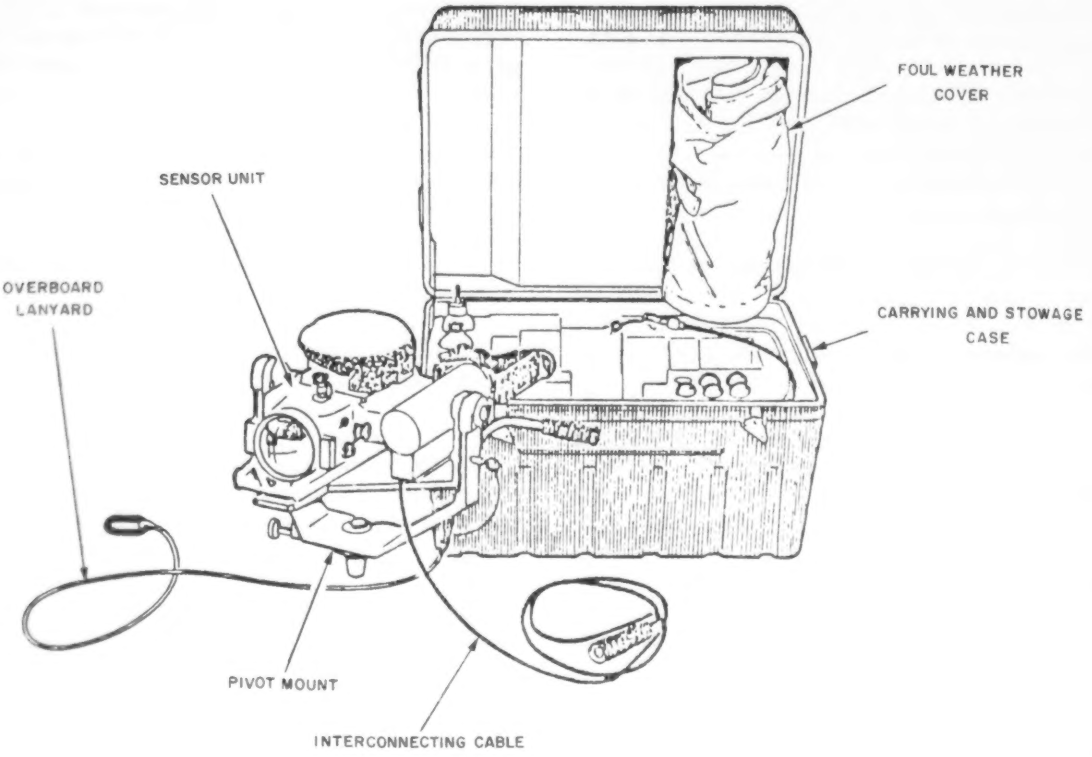


Figure 9-10.—Chemical warfare directional detector (CWDD) and stowage case.

Chemical Warfare Directional Detector (CWDD) AN/KAS-1

The Chemical Warfare Directional Detector (AN/KAS-1) system (fig. 9-10) is a passive, infrared imaging sensor. Its primary function is to provide U.S. Navy ships with the capability to detect and identify a chemical warfare (CW) agent attack. The AN/KAS-1 can be used to detect and identify nerve agent attacks against sister ships in a task force, against waves of amphibious assault ships and boats proceeding ashore, or against assault forces in the vicinity of the landing area. Chemical warfare agent cloud detection and identification can be accomplished against a sky background for all conditions under which CW attacks may be expected to occur. Detection of CW activity against a land background can be accomplished also, but less effectively.

The AN/KAS-1 infrared sensor gives the equipment a secondary function of low-visibility/night pilotage and area surveillance. The operator of the AN/KAS-1 can detect and provide relative bearing to prominent land features, such as lighthouses and water towers. In the future, the AN/KAS-1 may be approved for the detection of buoys and personnel on the water's surface.

The AN/KAS-1 is a shipboard mounted, portable unit. It consists of a sensor unit, a pivot mount, a power conversion unit (PCU), a carrying and stowage case, a maintenance kit, an overboard lanyard, and a foul weather cover.

The sensor unit (fig. 9-11) is equipped with the following controls.

- A field of view switch. This switch enables you to use a wide field of view (WFOV) and a narrow field of view (NFOV).

- A range/focus knob.

- A brightness knob.

- A contrast knob.

- A filter wheel switch. This switch allows you to rotate a wheel positioned in the optical chain of the unit through the following

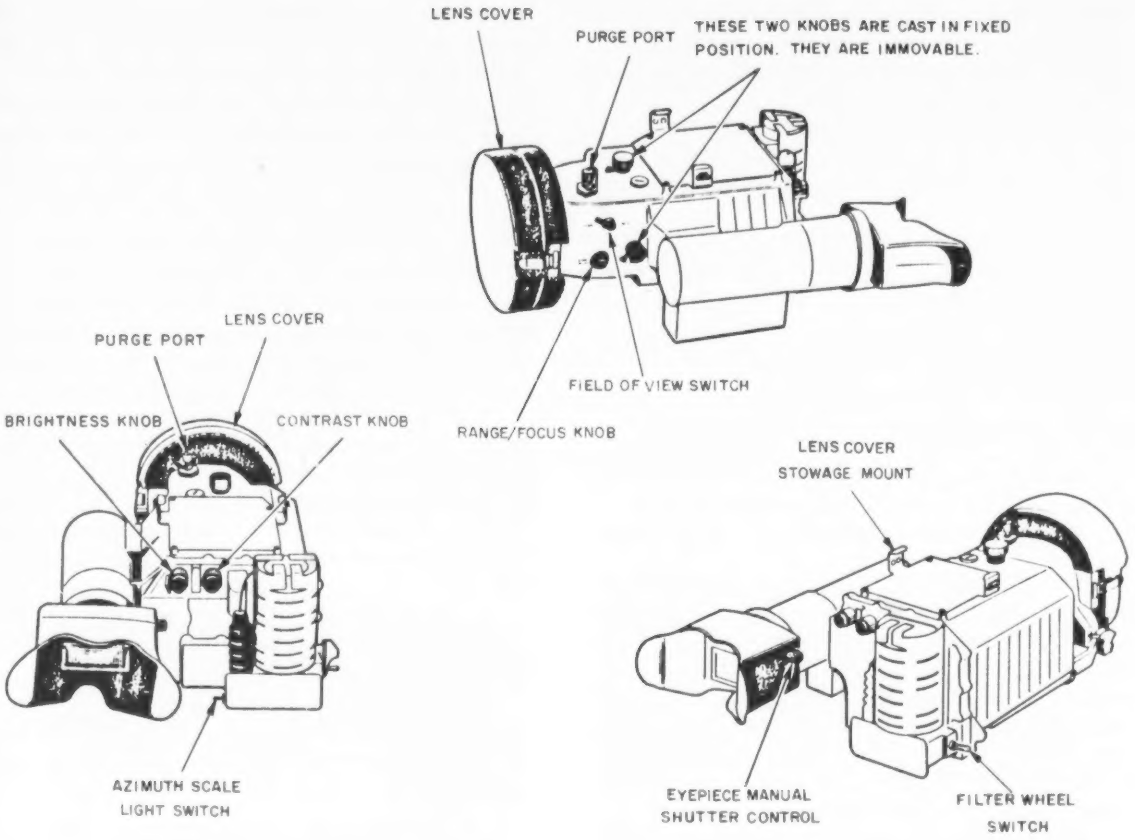

LENS COVER
PURGE PORT
THESE TWO KNOBS ARE CAST IN FIXED POSITION. THEY ARE IMMOVABLE.
FIELD OF VIEW SWITCH
RANGE/FOCUS KNOB
LENS COVER
PURGE PORT
BRIGHTNESS KNOB
CONTRAST KNOB
AZIMUTH SCALE LIGHT SWITCH
LENS COVER STOWAGE MOUNT
EYEPIECE MANUAL SHUTTER CONTROL
FILTER WHEEL SWITCH

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Figure 9-11.—Three views of the chemical warfare directional detector.

positions: filter 1, filter 2, filter 3, and filter out. This is referred to as interrogating. These filters are used to identify CW nerve agent clouds.

The pivot mount provides the mechanical interface between the sensor unit and the standard bracket and lock assembly. The pivot mount provides a minimum elevation of −35° to +45° and 360° of azimuth. Handlebars are provided to assist you in positioning the sensor unit. The interconnecting cable provides electrical connection and power transfer from the PCU to the sensor unit through a coiled, double-shielded cable.

The power conversion unit (fig 9-12) provides operating power to the sensor unit from the ships 115 vac 60 Hz supply. Press-to-test switches and lights are included to verify input and output voltages. The unit consists of an electronics tray contained in a watertight, protective housing.

The carrying and stowage case is provided for transportation and stowage of the AN/KAS-1

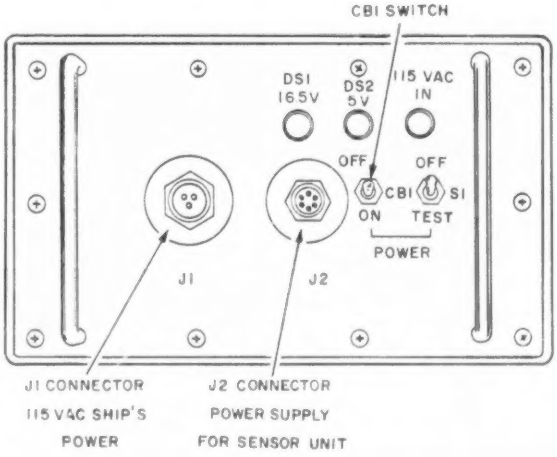
CBI SWITCH
DS1 16.5V
DS2 5V
115 VAC IN
OFF
ON
CBI
OFF
SI
TEST
POWER
J1
J2
J1 CONNECTOR 115 VAC SHIP'S POWER
J2 CONNECTOR POWER SUPPLY FOR SENSOR UNIT

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Figure 9-12.—Power conversion unit (PCU).

system. Space is also provided in this case for the stowage of the sensor unit, pivot mount, interconnecting cable, overboard lanyard, maintenance kit, and foul weather cover.

The maintenance kit (stowed inside the carrying and stowage case) is provided with each system. The maintenance kit contains the following:

- Expendable nitrogen gas cartridges (six) to purge the sensor unit of moisture (30-day requirement)
- A purge kit regulator and connector assembly
- Lens wipers (cleaning pads)
- A lens cleaning solution
- Spare bulbs and lenses

The overboard lanyard is a vinyl-covered, stainless steel cable. It is used to secure the sensor and pivot mount unit to an eyelet on the PCU unit mounting plate prior to installation and/or removal. The overboard lanyard and associated safety procedures prevent accidental over-the-side loss or severe damage to the equipment, due to a fall to a lower deck, during installation or removal of the sensor unit.

The foul weather cover, or waterproof canvas, is used to protect the sensor and pivot mount when they are not in use. (Do not cover the sensor unit with the foul weather cover while the unit is in operation. The confined heat that is generated by the sensor unit cooler will harm the sensor unit.)

Six AN/KAS-1 locations are to be established on each ship. Each location should be carefully chosen so that it has a wide field of view. The view should not be blocked by other hardware. Also, take care to avoid interference with other ship's equipment. The locations already selected for the Mk-37 night observation device (NOD) are usually excellent. When possible, the mounting locations should be high on the ship, such as on the signal bridge and pilothouse bridge wings. Finally, the locations must be accessible to sound-powered headphones.

Use the following procedures to put the AN/KAS-1 in position for use.

1. Have two people carry the AN/KAS-1 stowage case to the mount site to be used.
2. Remove the free end of the overboard lanyard from the case and secure it to the eyelet in the PCU mount.
3. Have the people carefully remove the sensor unit from the case by grasping it by the yoke, and then lift and turn the pivot mount to line up with the locater pins in the bracket and lock assembly mount. Move the unit into place on the mount.
4. Secure the sensor unit to the mount by securing the lock mechanism on the bracket and lock assembly. Try to lift the sensor from the mount to ensure that it is locked in place.
5. Position the left and right handles by placing one hand on the sensor assembly for support. Pull out each handle, one at a time, and rotate each one into a horizontal position.
6. Notify the support maintenance signalman to purge the sensor unit according to the applicable MRC from the PMS.
7. Free the lens cover by releasing the two side latches. Remove the lens cover and secure it to the lens cover stowage mount on top of the sensor unit with the two side latches.
8. Verify that the PCU CB1 switch is off, and then connect the sensor unit power cable to the PCU connector (J2).

After the AN/KAS-1 is set up, perform the AN/KAS-1 operator check procedure. Now the AN/KAS-1 system is ready to be aligned.

To set up the AN/KAS-1 for operation, use the following procedures:

1. Remove the canvas foul weather cover.
2. Push the button flap on the cover into the cover. Roll the cover up and secure it with the drawstring. Ensure that the cover is secured by its strap to the mount eyebolt. This will prevent the equipment cover from being blown overboard.
3. Remove the lens guard cushion by releasing the two latches, one on each side. Secure the lens guard cushion to the top of the sensor unit using the same two latches.
4. Rotate the mount control handles 180° into the operational position.
5. Release the elevation stow pin and azimuth locks. Adjust the azimuth friction lock to the desired level of control.
6. Perform the AN/KAS-1 operator check procedure.
7. Check the sensor unit alignment with the alignment bench mark data engraved on the data plate. If necessary, perform the alignment procedure.

The AN/KAS-1 is now ready for operation.

To conduct the AN/KAS-1 operator check, turn on the PCU CB1 switch. The sensor unit cooler will operate. After about 3 minutes, the sensor will reach cool down and an IR scene should be visible in the eyepiece. If the IR scene is not visible or clear, use the following steps to troubleshoot the problem:

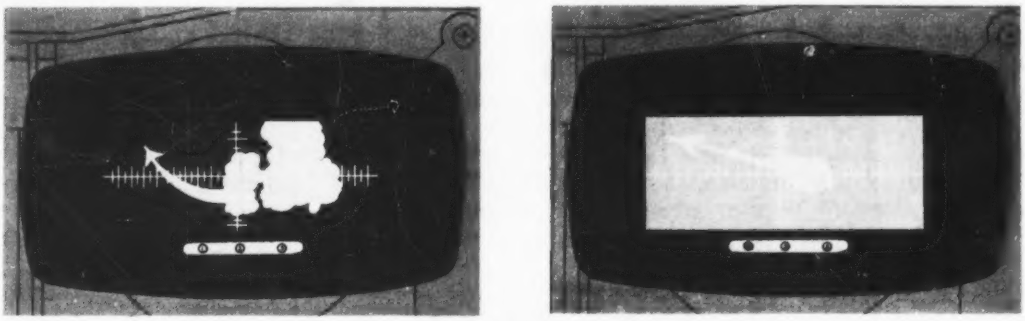
1. Place the PCU S1 switch in the test position. If all lights come on but there is no IR scene visible in the eyepiece within 5 minutes, replace the sensor unit. If the DS3 fails to light up, the ship's power to the PCU is OFF. Check the ship's power. If the DS3 lights up but there is no image and either the DS1 or the DS2 fails to light up, replace the PCU. If some of the lights are out but the IR scene is visible in the eyepiece, replace the defective lamp.

2. Adjust the BRT (brightness) and the CTRS (contrast) to obtain a good image. Remember this image, because on foggy or hazy days the image will not focus sharply. If you are in a low-visibility or heavy fog condition, use the narrow field of view and focus on a hot object within 50 feet of the sensor. If you are unable to obtain a good image, replace the sensor unit.

3. Using the narrow field of view, observe the hot object at 50 feet or more and image. Switch to the wide field of view and verify the focus. Always focus the AN/KAS-1 in the narrow field of view; this will focus the wide field of view also. If you are unable to focus the image, replace the sensor unit.

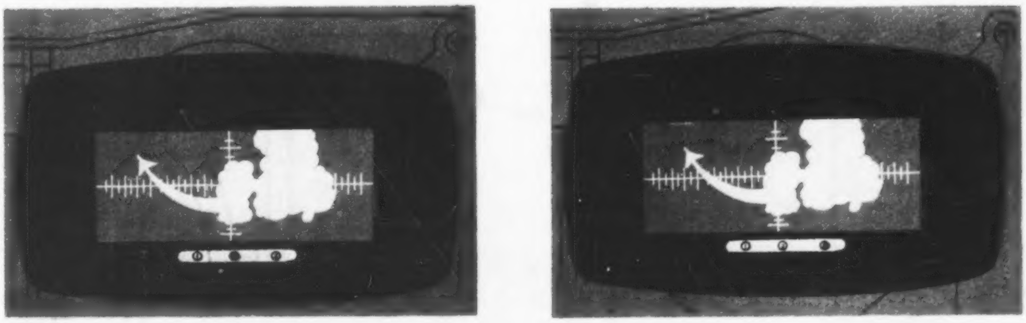
When you are identifying clouds (fig. 9-13), use the following procedures:

1. Use only the wide field of view so that the entire cloud can be seen.



A. NO FILTER.

B. FILTER ONE (1).



C. FILTER TWO (2).

D. FILTER THREE (3).

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Figure 9-13.—Interrogating with the chemical warfare directional detector (CWDD).

2. Aim the sensor unit at the cloud and begin your interrogating (moving through the filters) immediately by depressing the filter switch.

3. Go through the interrogation several times, watching the changes as the cloud forms. If the cloud is a chemical nerve agent cloud, the changes will become even more apparent as you watch it through the filters.

4. Continue the interrogation for at least six cycles until confirmation can be established.

5. If the cloud dims and grows smaller when using filter No. 1 and grows larger when using the No. 2 and No. 3 filters, take immediate action to notify the bridge. Even if the suspected cloud is not a chemical agent, keep interrogating other suspicious looking clouds.

When conducting maintenance on the AN/KAS-1, follow the procedures listed in the manufacturer's technical manual and the PMS system.

Chemical Agent Point Detector System (CAPDS)

The chemical agent point detector system (fig. 9-14) is a local sampling detection device. It is used to detect the presence of chemical agents in the air. The system has an alarm that provides rapid warning. The CAPDS is capable of detecting nerve agents GB, GD, and VX in time to allow personnel to take protective countermeasures. The system provides a means of continuously sampling the outside air. It will automatically sound an alarm at the remote control unit and remote status unit.

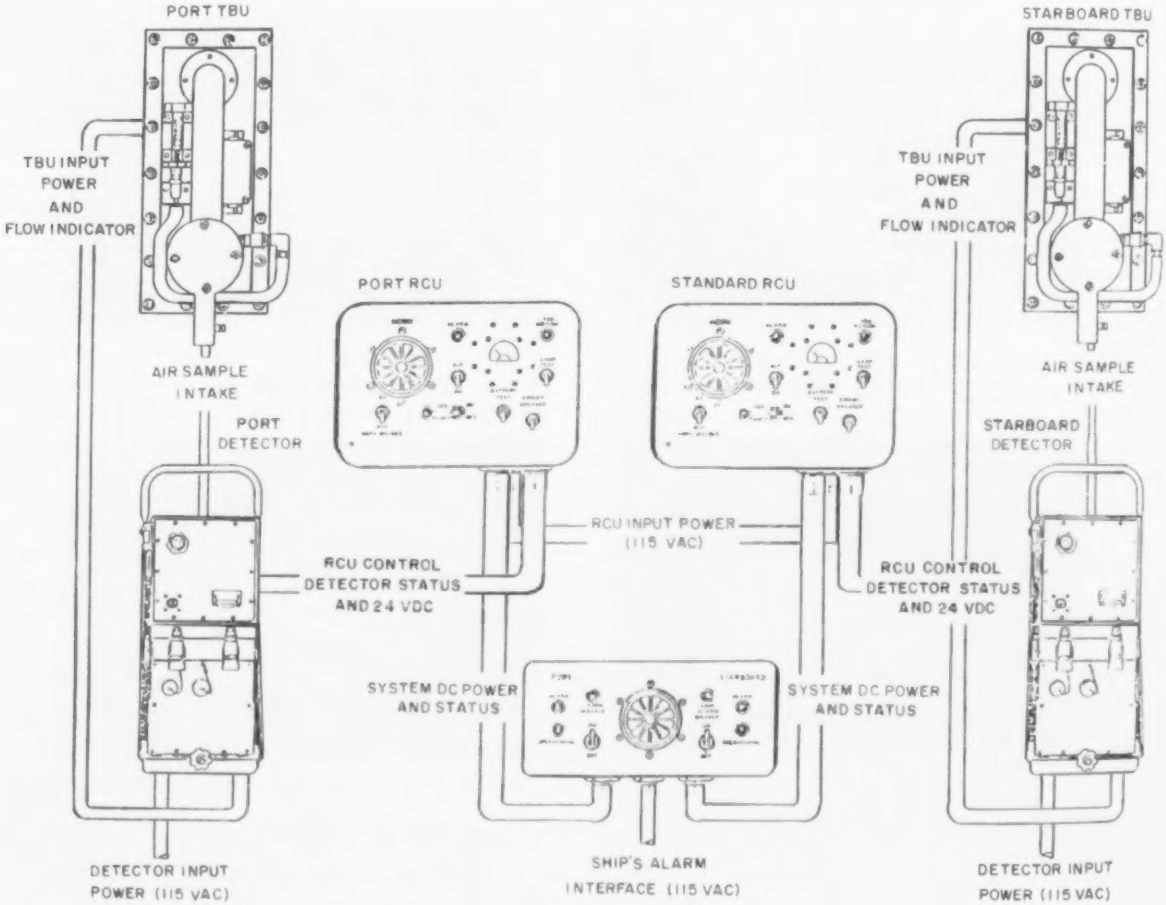
PORT TBU
STARBOARD TBU
TBU INPUT POWER AND FLOW INDICATOR
TBU INPUT POWER AND FLOW INDICATOR
PORT RCU
STANDARD RCU
AIR SAMPLE INTAKE
AIR SAMPLE INTAKE
PORT DETECTOR
STARBOARD DETECTOR
RCU INPUT POWER (115 VAC)
RCU CONTROL DETECTOR STATUS AND 24 VDC
RCU CONTROL DETECTOR STATUS AND 24 VDC
SYSTEM DC POWER AND STATUS
SYSTEM DC POWER AND STATUS
DETECTOR INPUT POWER (115 VAC)
SHIP'S ALARM INTERFACE (115 VAC)
DETECTOR INPUT POWER (115 VAC)

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Figure 9-14.—Chemical agent point detection system (CAPDS).

The CAPDS consists of a detector, two through-the-bulkhead units (TBU), a remote control unit, and a remote status unit.

The detector consists of the alarm module and the power supply. The alarm module contains a pneumatic system, an ionization and detection system, and an alarm electrical system, which is necessary to perform the agent sampling operations. The pneumatic system is used to supply air samples from the TBU to the alarm module for chemical analysis. It will then remove the air sample once the sample has been analyzed as exhaust.

The ionization and detection system draws air samples into a heater block where it is heated to a temperature of approximately 140°F. The sample moves into a sensor cell for ionization. A sample containing chemical agents will increase the sensor cell's output and trigger the alarm. The alarm electrical system provides the power to maintain airflow, heater temperature, and the other electrical systems involved.

The power supply provides the input power from the ships electrical system. If the input power is lost, the power supply provides the power from an internal battery.

The through-the-bulkhead unit consists of an electronics and fan assembly. This assembly provides continuous air samples for the alarm module.

The remote control unit connects the remote status unit with the appropriate detector and the power supply. The remote status unit is mounted on the ship's bridge but has no control over the system. It merely reports the status of the system. However, it does have a manual override of the ship's alarm system.

Since the system is automatic, it requires no operation procedures once it is installed. To perform maintenance on the system, follow the guidelines listed in the planned maintenance system.

SUMMARY

In this chapter, you were introduced to biological warfare and chemical warfare operations, defense, and countermeasures. The various types of BW agents and CW agents were also described. Finally, you were introduced to various methods and equipment that are used to detect either BW agents or CW agents. Advancements are continuously being made to ensure that the Navy will be able to effectively conduct BW and CW defensive and countermeasures. As new equipment and systems are introduced to the Navy, read the manufacturer's technical manual to familiarize yourself with the new equipment and systems.

CHAPTER 10

CBR DEFENSE

CBR defense means defense against chemical or biological agents used in attacks or defense against radiation from nuclear explosions. As a Damage Controlman, you have certain duties in this type of defense. Your major duties are to detect and identify contamination, to decide on the protective measures needed, and to decontaminate ship surfaces, equipment, and personnel.

You will need to know the currently approved methods of defense and protection to the extent that you become a specialist in the field. This chapter will give you the basic information you need to move toward that goal.

In studying CBR defense, remember that weapons are always being developed and new defensive measures are being established to deal with them. You will need to keep up to date with these changes.

ORGANIZATION FOR CBR DEFENSE

CBR defense requires organization, specific procedures and responsibilities, and training. The organization and procedures are basically set up by ship's bills. Training is partially covered by the ship's bills, but it is a continuing responsibility that extends beyond them.

The ship's bills that apply to shipboard CBR defense include the general emergency bill; the biological, chemical, and radiological defense bill; and the ship's battle bill. All personnel must be indoctrinated and trained to carry out the duties described in these bills. The first two are described briefly in the following paragraphs. For information on the ship's battle bill and for additional information on other bills, see *Standard Organization and Regulations of the U. S. Navy*, OPNAVINST 3120.32.

The general emergency bill replaced the collision bill and abandon ship bill. It is prepared in accordance with type commander directives. It provides organization to counteract any major emergency that arises aboard ship. This bill covers large explosions and extensive fire, storm, or battle damage. The established battle organization is the basis for assignments in this bill. The exception is when the ship is in port with a partial crew aboard and assignments are made on the basis of duty sections.

The general emergency bill is maintained by the engineer officer who is responsible for seeing that the bill is current and ready for execution.

The biological, chemical, and radiological defense bill provides organization, establishes procedures, and assigns responsibilities for taking proper and effective action in the event of CBR attack or in the event of a CBR weapon accident. This bill is the responsibility of the engineer officer.

The biological, chemical, and radiological defense bill calls for the following measures:

1. These measures should be taken before an attack:
   - Indoctrinate and train the ship's crew
   - Eliminate contamination hazards
   - Activate a preattack water washdown
   - Mask exposed personnel
2. These measures should be taken immediately after an attack:
   - Conduct personnel evasive action
   - Conduct evasive maneuvering of the ship
   - Activate a water washdown
   - Evacuate and reman various stations
   - Decontaminate personnel

- Detect contaminated areas
- Decontaminate material

INDIVIDUAL PROTECTION

Personnel under CBR attack should be protected through individual and group measures. Individual protection is of immediate concern. What you do in the first few moments after a CBR attack may determine whether or not you will survive. Know the symptoms of exposure to radiation and to biological and chemical agents. Know the action to take when you are exposed and any self-aid and first-aid measures that might help you or your shipmates. This knowledge may be the difference between life and death.

PROTECTION AGAINST AIR BLAST, UNDERWATER SHOCK, AND HEAT

Air blasts injure most topside personnel by picking them up and throwing them about. This is known as body displacement. Personnel below decks are usually injured by body displacement and loose gear. You can reduce injury if you hold on to solid ship structures and secure loose gear.

Underwater shock injures personnel located above and below decks. This happens through mechanical transmission of the water shock force throughout the ship structure, which causes a rapid upward acceleration of the deck. Personnel are, in effect, hit by the deck and thrown off balance into the overhead or bulkheads. You can reduce this type of injury if you hang on to solid ship structures, flex your knees, and rest on the balls of your feet. When underwater shock is expected, do not lie prone on the deck. This position exposes more body area to the forces transmitted through the deck.

Heat (also called thermal radiation) produces skin burns and eye damage among topside personnel and can ignite clothing or other combustibles. The injury may be reduced if you quickly cover exposed skin surfaces. At the same time, drop out of sight of the fireball or curl up on the deck to present a minimum target to the fireball.

Table 10-1 summarizes the action that you should take to reduce injury from air, surface, and underwater detonations for warning and no warning attacks. Hands-to-face evasion protects against air blast and thermal radiation. It is practicable only for topside personnel who are alerted by the flash.

Table 10-1.—Recommended Personnel Action Against Nuclear Detonations

Burst Type	Warning		No Warning
	Topside Personnel	Below Decks Personnel	Topside Personnel
Air	A	B	C
Surface	A	B	C
Under-water	B	B	--

A — Lie prone and hold on to solid ship structure.

B — Stand with knees flexed and hold on to solid ship structure.

C – Hands-to-face evasion.

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The following maneuvers reduce the vulnerability of topside personnel to both thermal radiation and the air blast effects of airbursts and surface bursts. You may still suffer flash blindness for up to 30 minutes in both situations even if you do use these maneuvers.

The first maneuver is for personnel in open topside areas (those who can quickly drop to the deck). When you see the flash or see the sky light up, close your eyes and immediately raise your hands to cover your face. At the same time, drop to the deck as rapidly as possible. Do not use your hands to break your fall; use your shoulder. Curl up to present a minimum target. You may feel the heat from the detonation. Between 2 and 5 seconds after the flash (depending on the weapon yield) or after the heat sensation is over, remove your hands from your face. Then immediately grab a solid ship structure firmly to prevent the air blast winds from blowing you overboard or against the ship's structure.

The second maneuver is for personnel in congested topside areas (those who cannot quickly drop to the deck; for example, those on a gun mount). When you see the sky light up, close your eyes and immediately raise your hands to cover your face. At the same time, crouch and bend your head down. You may feel the heat from the weapon. After the heat sensation is over, grab hold of a solid ship structure to keep from being blown overboard or against the ship's structure by the air blast.

SELF AID AND FIRST AID

You or your shipmates may be injured or become contaminated with radiological, biological, or chemical agents during an attack. If so, you can increase your chances of survival if you immediately administer certain self aid and first aid. Self aid consists of those measures which you can apply to help yourself. First aid is the help rendered by nonmedical personnel to a casualty until medical help arrives.

Radiation Injuries

The blast and heat injuries from a nuclear explosion are treated the same as those from high explosive bombs, incendiary weapons, and mechanical accidents. Fractures, concussions, lacerations, contusions, hemorrhages, burns, shock, and exposure are treated with standard self-aid and first-aid measures.

There is nothing that needs to be done immediately for nuclear radiation sickness. Remember that you can receive a dose of radiation even though you are NOT contaminated with radioactive particles. If there is the possibility that you have been exposed to nuclear radiation, be sure you are checked and treated by medical personnel.

If directed, proceed to a personnel decontamination station. Discard your clothing and equipment and take a shower using plenty of soap and warm water. In washing, pay close attention to the hairy parts of your body, body creases, and fingernails, where dirt tends to gather. Radiation concentrates in those places.

Biological Agent Injuries

Since symptoms caused by pathogenic biological agents may not appear for some time, you may not know that a biological attack has occurred. However, if you suspect biological contamination, put on your protective mask and observe the basic principles of preventive medicine. These include individual hygiene, sanitation, and physical checkups. Report any illness to medical authorities immediately.

If there is a possibility that you have been contaminated by biological agents, take the following actions: Carefully remove your clothes to avoid spreading any contamination, and take a thorough soap and water shower as soon as possible. Change your clothes and dispose of contaminated clothing as directed. Pay carefully attention to your face and hands. Use a fingernail brush to remove dirt under your nails. Brush your teeth and gums frequently, including the roof of your mouth and your tongue.

Some biological agents take effect with great speed. You should apply first aid or self aid immediately if you think you may have been exposed.

Chemical Agent Injuries

At the first sign of a chemical agent in the atmosphere, put on your protective mask immediately. You must hold your breath until the mask is on and properly adjusted. Wear the mask constantly until you are sure there is no chemical agent in the air and the all-clear signal is given.

If a liquid nerve or blister agent gets on your skin or clothing, take immediate action. If your clothing is contaminated, find a place away from the source of contamination where you can remove and discard the clothing. Put on new clothing and continue your duties. If you believe your skin may be contaminated, treat yourself with the M258A1 skin decontaminating kit. DO NOT GET ANY OF THE CHEMICALS FROM THE KIT IN YOUR EYES OR MOUTH. The treatment requires the use of two packets: DECON 1 WIPE and DECON 2 WIPE, which are found in the kit. Use these packets according to the instructions on the M258A1 carrier.

After you use the packets, you should occasionally examine the contaminated areas for local sweating and muscular twitching. If none develops in the next half hour and you have no tightness in your chest, your self aid was successful and you can forget it. If these symptoms do occur, immediately use your atropine and 2 pam-chloride injectors. These injections should be self-administered, through your clothing and into the outside of your thigh. If no other symptoms develop, one injection each of atropine and 2 pam-chloride is enough. Dryness of the mouth is a good sign indicating that you have had enough atropine.

If nerve agent symptoms persist, you may give yourself up to two more injections of atropine and 2 pam-chloride at 10-15 minute intervals. More than three injections may be given only under the direct supervision of medical personnel or under direction of the petty officer or officer in charge of the battle station.

If a drop or splash of liquid nerve agent should get into your eye, take instant action to avoid serious symptoms. Quickly open a container of uncontaminated water, tilt your head back so that your eyes look straight upward, and flush your eye for not less than 30 seconds. This must be done in spite of the presence of nerve agent vapor. Hold your breath as much as possible during this procedure. If you cannot hold your breath for 30 seconds, rinse for as long as you can hold your breath, but put on the mask before breathing. After taking several breaths with the mask on, remove the mask and then complete decontamination. As soon as the flushing is completed, put the protective mask back on at once. Watch the pupil of the contaminated eye during the next minute. Use a mirror if one is available or have someone nearby do it. If the pupil gets rapidly smaller, inject one of your atropine automatic injectors at once into the outside of your thigh. If the pupil does not get smaller, the eye was not contaminated by the nerve agent. Do not use atropine until you are sure that the symptoms are those of nerve agent poisoning.

Exposure to high concentrations of nerve agents may bring on a lack of coordination, mental confusion, and collapse so fast that you may not be able to perform self-aid measures. If this happens, the nearest person should apply first aid.

Severe nerve agent exposure may rapidly cause unconsciousness, muscular paralysis, and loss of breathing. When this occurs, atropine and 2 pam-chloride alone will not save a life. Start artificial respiration immediately and continue until either natural breathing is restored or the casualty can be taken over by medical personnel. An atropine injection increases the effectiveness of artificial respiration. It should be administered as soon as possible, preferably by someone who is not performing the artificial respiration.

Whenever liquid or vaporized blister agents are known to be present, be sure to wear the protective mask. Liquid blister agents in the eyes or on the skin must be dealt with immediately by the individual concerned.

If liquid blister agent in the eye does not cause immediate pain, decontaminate by flushing the eye with water for at least 30 seconds. Try to regulate the flow of water so that flushing lasts not less than 30 seconds and not more than 2 minutes. Since decontamination with water effectively removes mustard, this procedure is now standard for all agents.

The risk of leaving blister agents in the eye is much greater than the risk of exposure to blister agent vapors. Therefore, the decontamination procedure MUST be performed in spite of the presence of vapor.

Phosgene oxime (blister agent) reacts rapidly with tissue. Therefore, decontamination will not be entirely effective after pain has started. Nevertheless the contaminated area should be flushed as rapidly as possible with large amount of water to remove any phosgene oxime that has not yet reached the tissue.

In the case of blood agents, speed in first aid is absolutely essential. If you notice any stimulation of breathing, an odor of bitter almonds, or any irritation of the eyes, nose or throat, mask at once. Blood agents act rapidly. Within a few seconds after exposure, you probably will not be able to put on the mask by yourself. Try to hold your breath until the mask is on your face, if at all possible. This may be very difficult, since blood agents strongly stimulate respiration.

There is currently no self-aid or buddy-aid treatment for blood-agent symptoms. Affected personnel should seek medical attention immediately.

Irritation of the eyes or a change in the taste of a cigarette might indicate the presence of phosgene, a choking agent. Smoking may become tasteless or offensive in taste. If any one of the signs occur, hold your breath and put on your protective mask at once. Unless you have difficulty in breathing, have nausea or vomiting, or more than the usual shortness of breath on exertion, continue your normal combat duties. If any of these symptoms occur, you should rest quietly until you are evacuated by medical personnel.

CONTAMINATION CONTROL AREA/ DECONTAMINATION STATION

A contamination control area is a space about 8 feet by 8 feet designated for use by personnel who are leaving a contaminated outside deck and entering uncontaminated or decontaminated parts of the ship. These areas will usually include a personnel decontamination (decon) station for personnel who have been exposed to chemical, biological, or radiological contaminants. These areas should not be located deep inside the ship; contaminated personnel would have to pass through uncontaminated areas to get to the decon stations. Instead, these areas should be located as near as possible to the skin of the ship and at the weather deck. If an inside space is not available, a covered outside space can be used. These areas should also be convenient to showers that must be used in the decon process. Washrooms may be used as showers if salt water and freshwater showers have been installed in them.

Contamination Control Areas

Each contamination control area should be under the supervision of a repair party leader assisted by two HT operators and one medical corpsman, or the equivalent number of training personnel. Each area should have the following supplies:

- Eight 8-ounce bottles of high test hypochlorite (HTH), two 5 gallon pails, two 2-inch by 2-inch by 6-inch metal or plastic trays, two standard deck brushes with handles, six pair of standard corpsman shears, about 1 gallon of laundry detergent, and six 30-gallon capacity plastic bags with ties

- Thirty M258A1 personnel decon kits

- One M256 vapor detector kit, some M8 and M9 detector paper, and one chemical agent monitor

When the stand down order is given, the contamination control area manning team in full mission oriented protective posture (MOPP) will monitor and decontaminate the contamination control area spaces (MOPP is covered later in this chapter). If liquid contamination is suspected, they will clean the spaces with a 9 percent solution of HTH in salt water. They will follow this with detergent scrubbing and a salt water rinse. When decontamination of the contamination control area is complete, the repair party leader will supervise the flow of exposed personnel through the decon station.

Decontamination Station

A decontamination (decon) station should be about 8 feet by 8 feet. It should have an entrance from the outside, and an exit into an uncontaminated area near showers. If you have been exposed to contamination, you should use the following decontamination procedures. Do not remove your gas mask until a monitor tells you it is safe to do so.

1. Remove raingear and battle dress just outside the decon station. Trash cans, bags, or other storage will be provided for this purpose. At this time you will be monitored to see if you are contaminated. If you are not contaminated, you will be directed to enter uncontaminated spaces through another route. If you are contaminated, you will be sent through the process described in paragraph 2 through 6 below.
2. Enter the first part of the decon station in pairs. Use the buddy system to do gross decon of masks and gloves with the M258A1 personnel decon kits. Decon boots by immersing them in the 2-inch by 2-inch by 6-inch pans filled with a 9 percent HTH and water solution.
3. Move to the second part of the decon station where attendants will cut away your smock and help remove your trousers and boots. The contaminated clothing will be placed in trash bags for disposal.
4. Move to the showers, soap and wash your entire body thoroughly, and rinse well. Pay special attention to fingernails, hairy parts of the body, and hidden parts where contamination tends to concentrate.
5. You are now ready to enter the clean part of the ship where you will put on new clothing. Before you enter the clean part, a monitor with a low range radiac will check to ensure that you no longer carry contamination. Turn over your DT-60 dosimeter to this monitor, who will take the readings and enter them in the log. You will be told at this time if you can remove your gas mask.

MISSION ORIENTED PROTECTIVE POSTURE

Mission oriented protective posture (MOPP) procedures are used to establish levels of readiness for a chemical agent attack. The procedures are flexible. They allow the commanding officer to adapt the requirements for protective clothing and equipment to the degree of threat and working conditions at any given time. As an example, personnel doing heavy work in hot weather may suffer heat exhaustion in the heavy protective clothing and gas masks. Therefore, unless an attack is actually underway, it may be best to relax the protective clothing requirements to prevent certain injury or sickness from heat. Other cases are personnel who cannot do their work wearing protective gear, those who need to eat or attend to body functions, and other requirements not possible in protective clothing. For detailed information on MOPP, see chapter 470 of the *Naval Ships' Technical Manual.*

PROTECTIVE EQUIPMENT

All naval personnel, particularly Damage Controlmen, should be familiar with the protective equipment designed for CBR defense. The following paragraphs cover protective masks and clothing.

PROTECTIVE MASKS

The protective mask is your single most important piece of protection against CBR attack. You inhale about 10 liters of air each minute and even more when you exercise. You can see that you can inhale a lot of CBR contamination very quickly. The protective mask filters those contaminants out of the air you breath.

The protective mask now in use in the Navy is the ND Mk V (fig. 10-1). It is made up of two main parts: the facepiece and the canister system. The mask is kept in a carrier until it is needed (fig. 10-2).

The facepiece should fit snugly over your face to form a perfect gastight seal. This seal protects your eyes, face, and lungs. Use the harness assembly to strap the mask to your head and secure it firmly. The mask has eyepieces and a speaking diaphragm for voice communication. A one-way valve allows you to exhale to the atmosphere, but not to inhale from the atmosphere. A connection assembly allows you to inhale from the canister.

The canister consists of a metal body containing a mechanical and chemical filter system. The mechanical filter is a fine screening material that collects particles—biological and chemical agents, radioactive dust, and smoke particles. The chemical filter absorbs vapors that pass over the porous surface of activated charcoal and are caught in the small holes and condensed. The mask protects against most chemical agents in normal concentrations. Certain gases, such as carbon monoxide, carbon dioxide, ammonia, and commercial fuel gases will pass through the canister. You will need special masks to protect against these gases. Information on these masks can be found under the subject headings in various chapters of the *Naval Ships' Technical Manual.*

The canister cannot supply or manufacture oxygen; it offers no protection from an oxygen-deficient atmosphere.

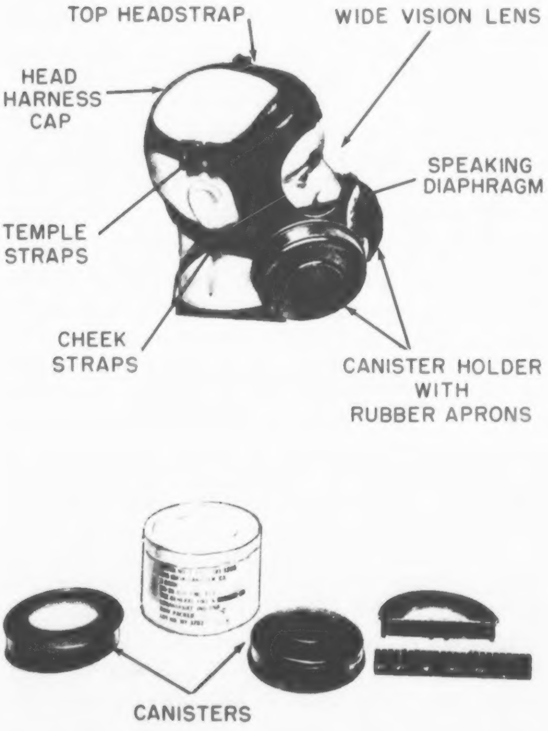

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Figure 10-1.—Nomenclature of ND Mk V protective mask.

148
USN
GAS MASK
ND MARK V

3.179

Figure 10-2.—The ND Mk V protective mask and carrier.

Minimize exposure of the canisters to spray or rain. Replace canisters that have been soaked with water.

Each canister comes with seals over the intakes and outlets to keep out moisture. Remove and discard these seals when you put the canister into use. Do not try to replace the seals if the canister is used or left open more than a few minutes.

The Mk V mask has also been designated as an interim emergency breathing device for escape from smoke-filled areas where the oxygen content is above 18 percent. The mask should not be used as a working unit in fire fighting or as rescue apparatus.

NOTE: A new protection mask, the MCU-2/P, is now being tested for possible use as a replacement for the Mk V mask.

Care of the Mask

Be certain the Mk V mask is in good condition; it may be needed to save your life. Keep the mask dry. Moisture causes rotting of parts, corrosion of the metal, deterioration of the canisters, and mildewing of the carrier. Perspiration should be removed carefully.

Place only authorized equipment in the carrier.

Handle the masks carefully. Rough treatment may cause serious mechanical damage to the metal parts, tears in delicate portions, and scratched or broken lenses.

Inspect the masks regularly and make repairs promptly.

Place the mask properly in the carrier.

Store the mask in a cool, dry, dark place. If it is necessary to stow the mask unboxed, stacks should not have more than four masks. Do not store heavy material on the pile.

Clean masks thoroughly whenever they are stowed or exchanged. Remove dirt with soap and water. Oil and gasoline vapors weaken the rubber and are especially damaging to the activated carbon in unsealed canisters.

Test the masks before use. You can use improvised gas chambers for periodic tests. Ensure there is enough oxygen to sustain life if an improvised gas chamber is used.

It is best to handle mask repairs at shore-based industrial facilities. In forward areas, repairs will usually amount to patching leaks in facepieces, alterations to accommodate hard-to-fit faces, and replacements of inoperable parts. Do not repair canisters; if they become inoperable, discard them and get new ones.

The following procedure is recommended for the chemical decontamination of the Mk V protective mask. It is also satisfactory for biological decontamination, but an immersion period of 15 minutes is considered adequate for that purpose.

Dip complete facepieces with head harnesses in 9 percent warm calcium hypochlorite. Leave them wet or immersed 5 minutes, then rinse thoroughly in warm (then cool) fresh water. Dry them completely in a warm to hot current of air and test for agent residue. Any cloudy condition of the eyepiece should gradually disappear as water evaporates. Test the facepieces for CW agent by placing one or more in a tightly closed metal container and leaving in a warm area (100°F to 140°F) for 4 hours. Sample the air in the container using a detector kit. Insert fresh canisters once the mask has been decontaminated and is to be used again. Wearers of decontaminated masks should be watched by medical personnel for eye irritation.

If a supplementary method is required, masks can be aired in a current of warm to hot air (100°F to 140°F), from 2 days to 1 week. Masks should be supported to minimize stretch or distortion and not allowed to come in contact with oil or grease.

Putting on the Mask

The ND Mk V protective mask (figs. 10-1 and 10-2) should be put on according to the following general procedures:

1. When you are issued a mask, be sure that it fits properly. The facepiece is manufactured in only one size. You will need to fit the head harness straps for your comfort and protection.
2. After you have adjusted the straps correctly, thread the loose ends of the three top head harness straps through the buckles between the body and the sliding member. At this point the straps are permanently adjusted to fit your face. You need to loosen or to tighten only the lower straps each time you remove or replace the mask. Tag or mark your name plainly on both the mask and carrier.
3. Put on the protective mask as soon as possible after you hear the alarm or have any other reason to suspect CBR attack. You must hold your breath until you can put on the mask. If contaminating material gets on your face or in your eyes, remove it before you put on the mask.
4. Immediately after you put on the mask, clear it of any poisonous fumes. Put the heel of

your hand over the exhaust valve at the chin of the mask and then rapidly exhale to force air out the sides of the facepiece.

5. Immediately after you clear the mask, test it for airtightness. Place the palms of the hands over the intakes of the canisters and inhale deeply and slowly.

6. If the outlet valve sticks because of perspiration drying on it, loosen it by forcefully exhaling air or by massaging the valve either through the valve cover or by partially removing the cover.

You will have to train your personnel in the proper procedures for donning and removing the ND Mk V protective mask. The general procedures for going through a drill are described here.

At the command "gas," take the following steps:

1. Hold your breath and remove your headgear.
2. With your left hand, yank open the carrier.
3. Hold the bottom of the carrier with your left hand, and with your right hand, remove the mask from the carrier.
4. Slide your thumbs inside the facepiece under all the head harness straps. Grasp the top of the facepiece. Thrust your chin forward.
5. Hold your head still. Raise the mask to your outthrust chin and bring the harness over the back of your head.
6. Center the head pad.
7. Grasp the tab ends of the lower straps.
8. Close the outlet valve with the heel of the hand. Exhaust forcibly to clear the mask.
9. Test the mask for fit and for possible leakage by placing your palms over the canister. When you inhale normally, the mask should collapse against your face.
10. Resume breathing.
11. Replace headgear.
12. Fasten the carrier flap.

At the command "remove and replace mask," take the following steps:

1. Remove your headgear.
2. Loosen the two lower flaps.
3. Grasp both canisters. Pull the mask down, out, and up over your head.
4. Fold the head harness into the facepiece.
5. Open the carrier flap. Place the mask in the carrier, canister down, eyepiece away from the body. Secure the flap.

CAUTION: Always test for gas before unmasking.

Mask Accessories

Two of the most common accessories used with protective masks are Fogpruf 52 liquid and the M-258A1 kit, which are described below.

- Fogpruf 52 liquid is used to reduce fogging of the lenses of the protective mask. To use Fogpruf 52, apply the liquid to both surfaces of each lens. Clean thoroughly with a cloth. Then apply the liquid again, spread it, and let it dry. Finish with a light buffing with the cloth that is supplied with the liquid.

- The M258A1 personal decontamination kit contains materials to decontaminate exposed skin areas. The kit is housed in a plastic waterproof case with a metal strap hook for easy attachment to clothing or equipment. This kit consists of three Decon 1 towelette wipes and three Decon 2 towelette wipes that are sealed in tear-away, impermeable foil packets. The Decon 1 packet has a tab for immediate identification at night.

- The Decon 1 packet contains a pad prewetted with hydroxyethane, phenol, sodium hydroxide, ammonia, and water. The Decon 2 packet consists of pad impregnated with Chloramine B, and sealed glass ampules filled with a solution of hydroxyethane, zinc chloride, and deionized water. The glass ampules are enclosed in a mesh bag to prevent injury to fingers or hand when crushing the ampules. The M258A1 kit is used to remove and decontaminate blister and nerve agents from the exposed skin. It can be used to decontaminate the face (except eyes and mouth), mask interior, rubber gloves, or rubber overboots. The kit contains supplies for three complete skin decontaminations.

PROTECTIVE CLOTHING

Various types of clothing are useful in CBR defense aboard ship. Some examples are impregnated clothing, the CBR protective suit, wet weather clothing, and ordinary work clothing.

Impregnated Clothing

This is sometimes called permeable clothing. It is supplied to ships in quantities large enough to outfit 25 percent or more of the ship's complement. Impregnated clothing is olive green in color. A complete outfit includes impregnated socks, gloves, trousers with attached suspenders, and a jumper (parka) with attached hood. Impregnated clothing is treated with a chemical that neutralizes the nerve agent VX and the mustards; a chlorinated paraffin is used as a binder. These chemicals give the impregnated clothing a slight odor of chlorine and a slightly greasy or clammy feel. The impregnation treatment should remain effective for 5 or 10 years or possibly even longer. If the treatment is to last that long, the clothing must be stowed in unopened containers in a dry place with cool or warm temperatures, and protected from sunlight or daylight. Wet weather clothing should be worn over the impregnated clothing topside. This combination is designated as X/Z clothing.

Impregnated protective clothing should not be worn longer than necessary where there is a threat of heat injury, especially in hot weather. Prolonged wearing may cause a rash to develop where the skin is in contact with the impregnated material.

NOTE: Impregnated clothing is being phased out and will be replaced with the CBR protective suit.

INSPECTION OF IMPREGNATED CLOTHING.—Make a visual inspection of each impregnated garment. Look for defects such as rips, tears, and worn places that might permit the passage of chemical agents. Test them for strength by taking a single layer of cloth in both hands and giving it a quick jerk; if the cloth gives way, it has rotted and must be discarded. Another method of testing for strength is to try to force the thumb or the blunt end of a pencil through the cloth; if this can be done easily, the clothing must be discarded.

CARE OF IMPREGNATED PROTECTIVE CLOTHING.—Observe the following precautions to prolong the life of impregnated protection clothing.

- Do not use impregnated clothing as general-purpose coveralls or for any purpose other than CBR defense or CBR defense training.

- Stow impregnated clothing in a dry, well-ventilated place and protect it from daylight.

- Do not allow impregnated clothing to remain in contact with oil, grease, moisture, dirt, or any type of organic solvent, such as gasoline, dry cleaning agents, or similiar compounds. Even the vapors from such solvents are harmful to the clothing. Do not use mothproofing agents on impregnated clothing.

- Do not place deteriorated impregnated clothing in contact with serviceable garments.

CBR Protective Suit

The CBR protective suit consists of two pieces—smock and trousers (fig. 10-3). The smock has two layers of materials: inner (antigas)

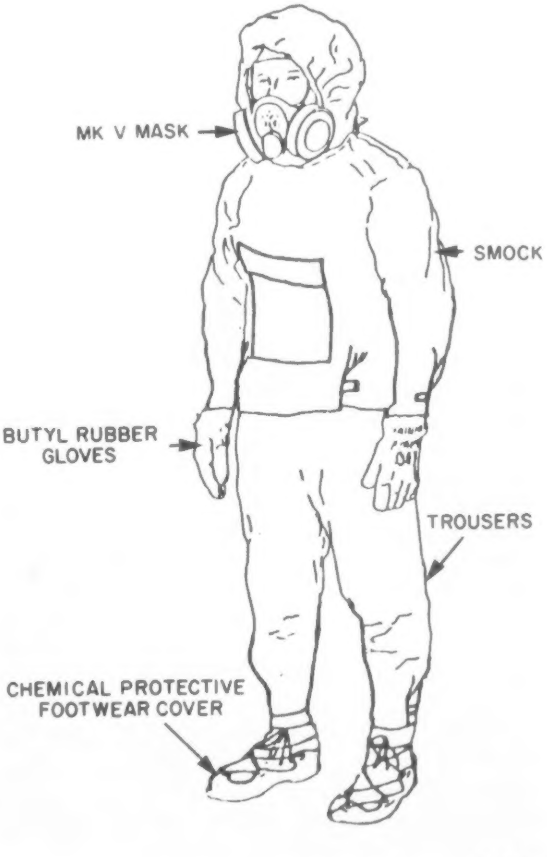

Figure 10-3.—CBR protective suit.

and outer (modacrylic/nylon). The smock is generously cut and has a back gusset to allow complete freedom of movement. There is a large front flap pocket for gloves and so forth, and a sleeve patch where you can place detector paper for easy visibility. You can make quick and easy adjustments by hook-and-pile and tape fastenings at the wrist and waist. The trousers are made of the same two layers of material and are cut with front gusset to allow for ease of fit. The trousers have suspender-type fittings located at the waist and across the shoulders. Front-tying and hook-and-pile fastenings are located at the base of each leg for adjustment. The CBR protective suit is issued in a mylothene envelope that is pressure pocketed, air evacuated, and heat sealed. It is then placed in a polyethylene bag and heat sealed. The suit has a shelf life of 5 years when unopened.

The protective suit protects against all CBR agents and is permeable to water vapor. Once removed from its protective envelope it will have a shelf life of 14 days in a nonchemical environment. If it is opened but uncontaminated, keep it for training purposes. Once exposed to chemical contamination, the CBR suit provides 6 hours of continuous protection after which it should be discarded.

Wet Weather Clothing

This ensemble, made of chloroprene-coated nylon, resists all liquid chemical warfare agents in a cold and/or wet climate. The parka is a jacket style with vulcanized side, neck, shoulder, hood, and sleeve joining seams. The parka has a permanently attached hood, adjustable fastener tapes at the neck closure, take-up straps at the sides of the hood, foam lined cushion around the face opening, and a flexible visor. The parka also has two front patch pockets with flaps, a slide fastener front closure with moisture barrier flaps, a tunnel hem with adjustable drawcord at the bottom, and adjustable fastener tape tabs at sleeve bottoms.

The overalls have a bib front, high-back style, with vulcanized side seams, center front and back seams, and leg inseams. The overalls have a double buckle stitched to the back bib and secured to the bib front buttons. They have a gusset-type closure located on the right side and secured by a waist tab and adjustable patch assembly. Each hemmed leg bottom has a leg tab and an adjustable patch assembly attached.

The wet weather clothing ensemble is worn over the CBR protective suit to provide extra protection from chemical warfare liquid agents and under wet conditions. It may also be needed in high wind conditions to prevent liquid agents from penetrating the CBR suit. It will protect against chemical agents for 6 hours in a contaminated environment and may be decontaminated and reissued.

Ordinary Work Clothing

This type of clothing provides only limited protection against liquid agents and vapors. If other protective clothing is not available, two layers of ordinary work clothing (with improvised neck and sleeve closures) will provide some protection.

DECONTAMINATION

The basic purpose of decontamination is to remove or neutralize CBR contamination so that the mission of the ship can be carried out without endangering the life or health of assigned personnel.

Decontamination operations may be both difficult and dangerous. Personnel engaged in these operations must be throughly trained in the proper techniques. Certain operations, such as the decontamination of food and water, should be done only by experts qualified in such work. However, all members of a ship's company should receive adaquate training in the elementary principles of decontamination so that they can assist in emergency decontamination operations.

After an attack, data from CBR surveys will be used to determine the extent and degree of contamination. Contaminated personnel must be decontaminated as soon as possible. Before decontamination of installations, machinery, and gear is undertaken, appraisals of urgency must be made in the light of the tactical situation.

RADIOLOGICAL DECONTAMINATION

Radiological decontamination neither neutralizes nor destroys the contamination. Instead, it merely removes the contamination from one particular area and transfers it to an area in which it presents less of a hazard. At sea, radioactive material is disposed of directly over the side. At shore installations, the problem is more difficult.

Flushing with water, preferably water under high pressure, is the most practical way to decontaminate topside surfaces. Aboard ship, a water washdown system is used to wash down all the exterior surfaces. The washdown system consists of piping and a series of nozzles. They throw a large spray pattern on weather decks and other surfaces.

If the washdown system is turned on before contamination, it prevents heavy contamination of the ship by coating the weather surfaces with the flowing stream of water (see fig. 10-4). The flowing water carries away radioactive particles as they fall on the ship and prevents them from settling into cracks and crevices.

Washdown is much more effective as a preventive measure than as a decontamination measure. The washdown system may be used only periodically to prewet the ship and is then turned off to allow normal ship operations. It is still more effective than it would be if contamination had fallen on completely dry decks.

Some areas of the ship may become heavily contaminated before the washdown system is activated. If so, you may need to hose down such areas vigorously by using seawater under pressure as follows:

1. Hose from higher to lower surfaces, from windward to leeward and from bow to stern.

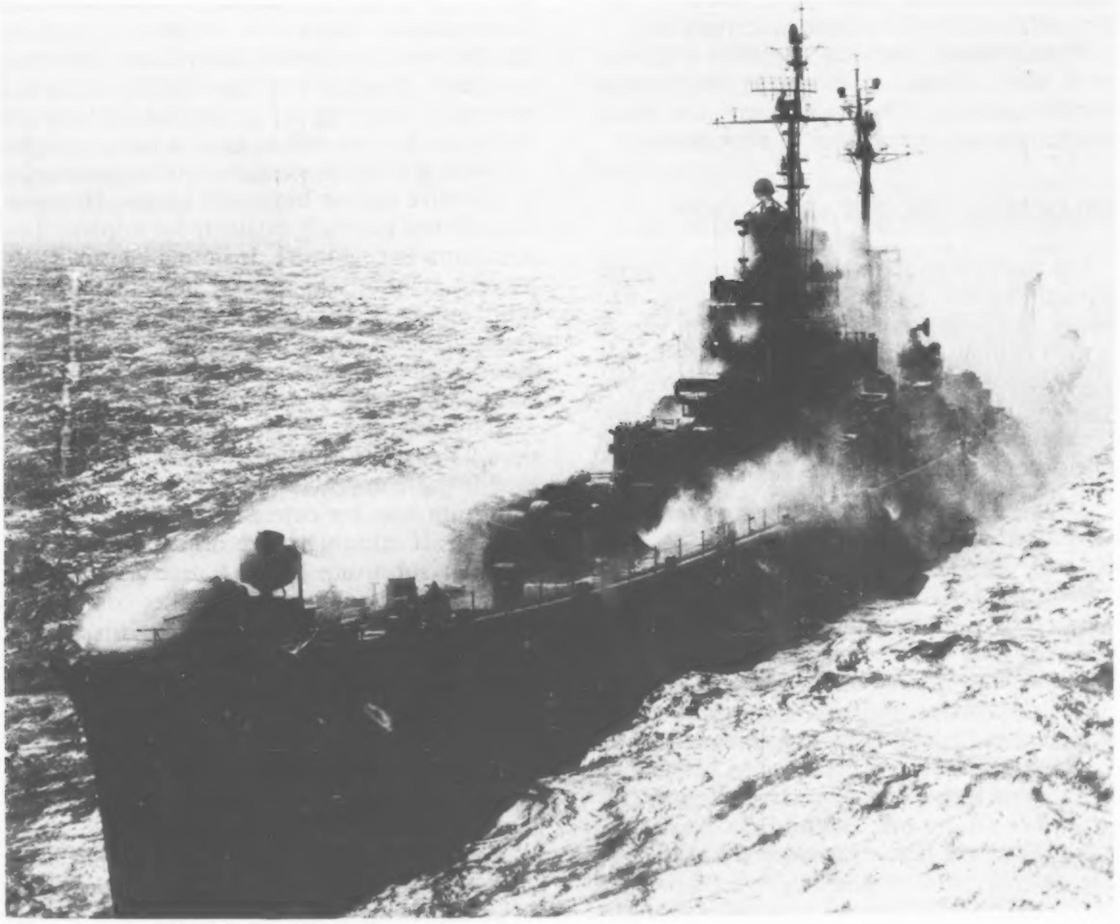

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Figure 10-4.—Water washdown system in action.

2. Direct the hose so that the water strikes the surface about 8 feet from the nozzle. Sweep the hose stream horizontally from side to side, moving lower on each sweep. Overlap the hosed areas somewhat on each sweep to ensure a complete washing. Direct the runoff into scuppers and deck drains as rapidly as possible. This keeps the contaminated water moving and prevents the formation of pools of contaminated water.

3. Take every possible precaution to see that contaminated water does not flow back over cleaner areas. Also, be sure that contaminated water is not hosed into the interior of the ship through vents, doors, or hatches.

Hosing down will be most effective if it is done after contaminating material has been deposited but before metal or painted surfaces have dried. However, contamination that has been deposited despite washdown will resist hosing alone. Vigorous scrubbing with deck brushes and detergents, followed by hosing, is required.

Ships without washdown systems will hose down with seawater as soon as the tactical situation permits. They will carry out other decontamination procedures as time permits.

BIOLOGICAL DECONTAMINATION

The most common methods used in biological decontamination are flushing, scrubbing, and heating. Sterilizing gases and disinfectant vapors are used in industrial decontamination, but they are not currently recommended for shipboard use. The method to be used in any particular case depends upon the nature of the area or equipment to be decontaminated.

Water Washdown

For the ship's exterior surfaces, the water washdown system (together with hosing down) will be the most effective countermeasure. After washdown and hosing, thorough scrubbing or swabbing with approved compounds will decontaminate any remaining biological agents.

Use the following procedures to hose down surfaces that have biological contamination.

1. Be sure the firemain pressure is at least 80 psi.

2. Work from top to bottom, from the windward side to lee side, and from forward to aft.

3. Hold the hose at a 30- to 40-degree angle so that the water will hit the deck 15 to 20 feet away from the nozzle. Use a solid stream.

4. Overlap the hosed areas to provide a complete washdown.

5. Control the drain-off to be sure it does not run into the ship.

Scrubbing

Use liquid disinfectants or decontaminants to decontaminate the ship's interior spaces. However, it is difficult to reach all contaminated surfaces to ensure that the liquid contacts the organisms. To overcome this problem, try to apply liquid disinfectants or decontaminants to all surfaces with a coarse spray device or with swabs until the surfaces are completely wet. Then rub or scrub all accessible surfaces with swabs or brushes to bring the organisms and the liquid into close contact. After this treatment, close the compartment for a prescribed period. Operating personnel should be equipped with masks and protective clothing as protection against the decontaminant as well as against the organisms.

Several liquid decontaminants have proved to be effective against biological agents. However, the only one generally available for shipboard use is calcium hypochlorite. It should be used in a 1 percent solution for general immediate decontamination and a 9 percent solution for heavily contaminated areas. (NOTE: Calcium hypochlorite and oil form an explosive hazard. Be careful when it is used.) This solution is more effective if a 0.5 percent detergent called decontaminating compound is added. If decontaminating compound is not available, you can substitute laundry detergents in the same percentages. If calcium hypochlorite is not available, you can substitute laundry detergents, soaps, dishwashing compounds, or boiler compound.

Calcium hypochlorite is a powerful oxidizing agent, and it is highly corrosive. The corrosiveness increases as the temperature goes up. Therefore, calcium hypochlorite should not be used to decontaminate sensitive electrical or electronic equipment on aircraft, weapons materials, navigation instruments, or similar equipment. This is especially true where steam is used.

In using calcium hypochlorite or other cleaning agents for biological decontamination, start at the highest point and work downward. Change the wiping cloths, waste, swabs, and scrub brushes at frequent intervals.

Steaming

Steaming is an effective method of decontamination for the ship's interior spaces. Admit enough steam to the compartment so that all air will be displaced. The compartment surfaces will then heat rapidly to the maximum temperature of approximately 212 °F. At this temperature, most germs are killed in about 15 minutes.

CHEMICAL DECONTAMINATION

The purpose of chemical decontamination is to decontaminate successfully after an attack by any of the blister or nerve agents. The methods generally used are natural weathering, chemical action, heat, and physical removal.

Natural Weathering

Natural weathering relies on the effects of sun, wind, and rain to dissipate, evaporate, or decompose toxic chemical agents. Weathering is by far the simplest and most common method of chemical decontamination. In some instances, it offers the only practical way to neutralize chemical agents, particularly where large areas are contaminated.

Chemical Action

Decontamination by chemical action involves a chemical reaction between the chemical agent and the chemical decontaminant. The reaction usually produces a harmless new compound or a compound that can be removed more easily than the original agent. Calcium hypochlorite is the chemical most often used aboard ship for both chemical and biological decontamination.

Heat

Expendable objects or objects of little value may be burned if they become contaminated. This procedure should be used only as an emergency measure or to dispose of material that has been highly contaminated. If you use this method, you need a very hot fire. Intense heat is required to destroy toxic chemicals. Moderate or low heat may only volatilize the agent and spread it in aerosol form. When a large amount of highly contaminated material is being burned, downwind areas may contain a dangerous concentration of toxic vapors. Keep personnel away from such areas.

Steam may be used to decontaminate chemical agents in interior compartments of the ship. The steam hydrolyzes and evaporates chemical agents and flushes them away from the surface. The effectiveness of the steam increases with temperature—the hotter the steam, the faster the neutralizing action. Use the following procedure to steam a compartment.

1. Introduce steam at 30 to 50 psi, using the air test fittings or other outlets.
2. Be sure that the compartment is entirely secured except for an exhaust line. The exhaust line should be led topside.
3. If possible, check the exhaust temperature. When the exhaust temperature is about 200 °F, reduce the pressure to 20 psi. If it is not feasible to check the exhaust temperature, assume that it is high enough after 15 minutes of steaming; then reduce the steam pressure to 20 psi.
4. Continue steaming for one-half hour or longer, depending upon the size of the compartment and the degree of contamination.
5. Check the exhaust periodically with a detector kit for residual traces of contamination.
6. After the steaming, clean the compartment thoroughly.

Although steam is noncorrosive quick acting and readily available aboard ship, it does have some disadvantages. It should NEVER be used to decontaminate lewisite (L), since another poisonous compound may result. Also, the high temperatures of steam decontamination can cause damage to some compartments and to certain types of gear. The moisture content of steam may also damage some equipment.

Physical Removal

Chemical decontamination can also be carried out by physically removing the toxic agents from the contaminated surfaces. This can be done by washing or flushing the surface with water, steam, or various solvents.

Decontamination can be accomplished with the water washdown system or by hosing. The procedures are similar to those used to flush away radiological and biological agents. However, there are some disadvantages. Water, like steam, must not be used for lewisite decontamination because of the poisonous residue that may be left. Also, flushing with water is not effective against blister gases unless it is done immediately after exposure to the blister agents before the agents penetrate any surfaces. The use of water may also release nonpoisonous but highly corrosive acids. Therefore, all surfaces must be washed thoroughly so that no reaction products remain. Hot water is much more effective than cold water for chemical decontamination. The effectiveness of water may be increased by the addition of soaps or detergents.

You may sometimes use solvents other than water to dissolve chemical agents so that they may be readily removed. These include gasoline, oils, alcohol, antifreezes, dry cleaning solvents, and so forth. Use them in accordance with appropriate safety precautions.

Alkaline solutions destroy G-agents (discussed in chapter 9) by hydrolysis. Alkaline solutions that may be used include lye, washing soda, ammonia, and baking soda. The stronger alkali solutions are more effective than the weaker ones.

Start decontamination as soon as possible after chemical attack. The priorities for decontamination vary, depending upon the type of ship and other factors. In general, you should use something similar to the following sequence of priorities.

1. Weapons equipment
2. Navigation equipment
3. Vital topside areas, such as gun mounts, the bridge, lookout stations, and areas which must necessarily be occupied by personnel
4. Vital machinery spaces
5. Topside areas from which the contamination could spread to the interior of the ship
6. Interior compartments
7. All other areas

CONTAMINATION MARKERS

Areas or objects that are contaminated by CBR attack must be clearly marked to warn personnel approaching the area. The markers should outline dangerous areas and thus establish boundaries within which you may exercise safety control. Radiation hot spots should be identified. These are areas where radiation intensities are significantly greater than the general radiation level of the surrounding areas.

The standard NATO system for marking areas that are contaminated by CBR attack is used by the U.S. Navy. The standard survey markers are shown in figure 10-5. Each marker is in the shape of a right triangle; one side of the triangle is about 11 1/2 inches long and the other two sides are about 8 inches long. The markers may be made of wood, metal, plastic, or other rigid material. Three holes are punched in each marker for rapid replacement.

The surface of a marker that faces away from the contaminated area is identified as the FRONT of the marker. The surface of the marker that faces toward the contaminated area is identified as the BACK of the marker. The fronts and backs are identified as follows:

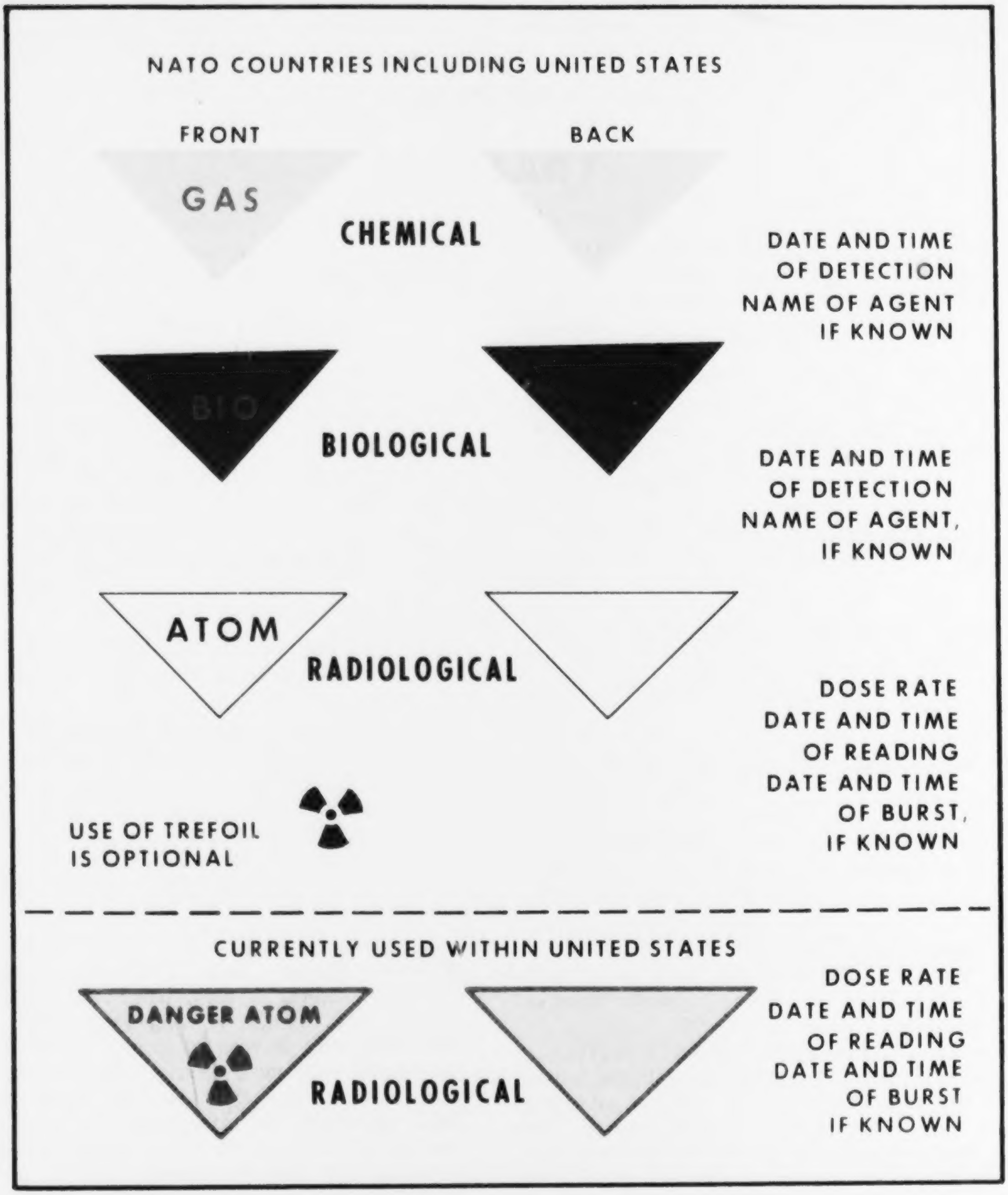
The chemical contamination marker has a yellow front with the word *gas* painted or written in red. The back of the marker is yellow. The date and time of detection of the chemical agent are written on the back, together with the name of the agent (if known).

The biological contamination marker has a blue front with the word *bio* painted in red. The back of the marker is blue. The date and time of detection of the biological agent are written on the back, together with the name of the agent (if known).

The radiological contamination marker has a white front with the word *atom* written or painted in black. The back of the marker is white. The dose rate, the time and date of the reading, and the time of the burst (if known) are written on the back.

SUMMARY

In this chapter you were introduced to the basic procedures used for defense against CBR attacks. We also discussed various protective equipment and clothing available for use at this time. Finally, we explained the procedures for CBR decontamination. As a Damage Controlman, you must remember that new approaches are constantly being tested. New weapons are being developed and new protective and defensive measures are being established all the time. Therefore, it is particularly important that you stay up to date in the area of CBR defense. Some sources of information are *Surface Ship Damage Control*, NWP 62-1, *Repair Party Manual*, *U. S. Navy Chemical Biological and Radiological Defense Handbook for Training*, and various naval ship's technical manuals.


NATO COUNTRIES INCLUDING UNITED STATES
FRONT
BACK
GAS
CHEMICAL
DATE AND TIME
OF DETECTION
NAME OF AGENT
IF KNOWN
BIO
BIOLOGICAL
DATE AND TIME
OF DETECTION
NAME OF AGENT,
IF KNOWN
ATOM
RADIOLOGICAL
DOSE RATE
DATE AND TIME
OF READING
DATE AND TIME
OF BURST,
IF KNOWN
USE OF TREFOIL
IS OPTIONAL
CURRENTLY USED WITHIN UNITED STATES
DANGER ATOM
RADIOLOGICAL
DOSE RATE
DATE AND TIME
OF READING
DATE AND TIME
OF BURST
IF KNOWN

C3.178

Figure 10-5.—Chemical, biological, and radiological contamination markers.

APPENDIX I

GLOSSARY

ADHESION—The molecular attraction exerted between the surfaces of bodies in contact.

ADJUSTMENT—To change the physical characteristics of an instrument to make it more accurate.

AFT—Near the stern; toward the stern. Not as specific as abaft.

AFTER—That which is farthest aft, as after fireroom.

AFTER BODY—That portion of a ship's body aft of the midship section.

AFTER PERPENDICULAR—A line perpendicular to the baseline intersecting the after edge of the stern post at the designed waterline. On submarines or ships having a similar stern, it is a vertical line passing through the point where the designed waterline intersects the stern of the ship.

AIR PORT—An opening in the side or deck house of a vessel, usually round in shape and fitted with a hinged frame in which a thick glass is secured. The purpose of the air port is to provide light and ventilation to and vision from the interior of the ship. In some instances the air port is also provided with an additional solid metal hinged cover for purposes of protection of the interior should the glass be damaged or to prevent light from showing from within.

AMBIENT—Surrounding, environmental (for example, ambient temperature refers to the temperature surrounding an instrument).

AMIDSHIPS—An indefinite area midway between the bow and the stern. Rudder amidships means that the rudder is in line with the ship's centerline.

AQUEOUS FILM FORMING FORM (AFFF)—A light chemical that, when mixed with seawater, produces a fire-extinguishing foam that covers a liquid fire and separates the fire from its oxygen supply.

ARMORED DECK—A deck, below the main deck, that provides added protection to vital spaces.

ASTERN—Signifying position, in the rear of or abaft the stern; as regards motion the opposite of going ahead; backwards. Directly behind a ship.

ATHWARTSHIP—Reaching across a vessel, from side to side.

ATMOSPHERE—A unit of measure equal to 14.696 psi or 29.92 inches of mercury (e.g. 1 atmosphere = 14.696 psi).

ATMOSPHERIC PRESSURE—The pressure of air at sea level, approximately 14.7 pounds per square inch.

AUTOMATIC BUS TRANSFER (ABT)—Normal and alternate power sources are provided to vital loads. These power sources are supplied from separate switchboards through separated cable runs. Upon loss of the normal power supply, the ABT automatically disconnects this source and switches the load to the alternate source.

BACK PRESSURE—(1) Refers to the resistance to the flow of exhaust fluids through the exhaust system. (2) The pressure exerted on the exhaust side of a pump or engine.

BALLAST—Any weight carried solely for the purpose of making the vessel more worthy. Ballast may be either portable or fixed, depending upon the condition of the ship. Fixed or permanent ballast in the form of sand, concrete, lead, scrap, or pig iron is usually fitted to overcome an inherent defect in stability or trim due to faulty design or change character of service. Portable ballast, usually in the form of water pumped into or out of the bottom, peak, or wing ballast tanks, is utilized to overcome a temporary defect in stability or trim due to faulty loading, damage, etc., and to submerge submarines.

BALLASTED CONDITION—A condition of loading in which it becomes necessary to fill all or part of the ballast tanks in order to secure proper immersion, stability, and steering qualities brought about by consumption of fuel, stores, and water or lack of part or all of the designed cargo.

BALLASTING—The process of filling empty tanks with saltwater to protect the ship from underwater damage and to increase its stability. See DEBALLASTING.

BALLAST TANKS—Tanks provided in various parts of a ship for introduction of water ballast when necessary to add weight to produce a change in trim or in stability of the ship, and for submerging submarines.

BALLAST WATER—Seawater, confined to double bottom tanks, peak tanks and other designated compartments, for use in obtaining satisfactory draft, trim, or stability.

BATTEN—(1) Long, thin, strips of wood, steel, or plastic, usually of uniform rectangular section used in the drafting room and mold loft to lay down the lines of a vessel, but sometimes thinned down in the middle or at the ends to take sharp curves. A strip of wood or steel used in securing tarpaulins in place. To secure by means of battens, as to "batten down a hatch." (2) Wooden bar or strip fastened to patterns to hold them straight or to prevent distortion through the ramming of the mold.

BATTEN DOWN—The act of applying battens to a hatch. Extended to mean the closing of any watertight fixture.

BATTENS, CARGO—A term applied to the wood planks or steel shapes that are fitted to the inside of the frames in a hold to keep the cargo away from the shell plating; the strips of wood or steel used to prevent shifting of cargo.

BATTENS, SEAM—Wood seamstraps which connect the edges of small boats having a single thickness of planking. They give additional stiffness to the plank, are continuous, and frames are notched out to fit over them.

BATTLESHIP—A naval vessel having a large displacement, good speed, large radius of action, maximum armament, maximum protection against gun fire, bombs, and torpedoes, ability to keep at sea in all weathers and to bear the brunt of sea fighting as a line-of-battle ship.

BEAM—The extreme width of a ship. Also an athwartship or longitudinal member of the ship's structure supporting the deck.

BEAM, TRANSOM—A strong deck beam situated in the after end of the vessel connected at each end to the transom frame. The cant beams which support the deckplating in the overhang of the stern are attached to and radiate from it.

BETWEEN DECKS—The space between any two, not necessarily adjacent, decks. Frequently expressed as "Tween Decks."

BILGE—(1) Bottom of the hull near the keel; (2) To fail an examination; (3) Bilge water is foul water, so to apply the term to oral or written statements implies that the statement is worthless. (4) To open a vessel's lower body to the sea.

BILGE KEEL—A keel attached to the outside of a ship's hull, near the turn of the bilge, to reduce rolling.

BILGE PLATES—The curved shell plates that fit the bilge.

BILGES—The lowest portion of a ship inside the hull, considering the inner bottom where fitted as the bottom hull limit.

BOLT—A metal rod used as a fastening. With few exceptions, such as drift bolts, a head or shoulder is made on one end and a screw thread to carry a nut is cut on the other.

BOOT TOPPING—An outside area on a vessel's hull from bow to stern between certain waterlines to which special air, water, and grease-resisting paint is applied; also the paint applied to such areas.

BORDER LINES—Dark lines defining the inside edge of the margin on a drawing.

BOSS—(1) The curved, swelling portion of the ship's underwater hull around the propeller shaft. (2) A projection on a casting of circular cross section.

BOSS PLATE—The plate that covers the boss.

BOTTOM—That portion of a vessel's shell between the keel and the lower turn of the bilge.

BOTTOM BOARD—A rough board similar to a molding board upon which the finished mold rests.

BOTTOM, OUTER—A term applied to the bottom shell plating in a double bottom ship.

BOTTOM PLATING—That part of the shell plating which is below the water line. More specifically, the immersed shell plating from bilge to bilge.

BREADTH, EXTREME—The maximum breadth measured over plating or planking, including beading or fenders.

BREADTH, MEASURED—Measured amidships at its greatest breadth to outside of plating.

BREADTH, MOLDED—The greatest breadth of the vessel measured from heel of frame on one side to heel of frame on other side.

BREAK OF FORECASTLE or POOP—The point at which the partial decks known as the forecastle and poop are discontinued.

BULKHEAD—A term applied to any one of the partition walls which subdivide the interior of a ship into compartments or rooms. The various types of bulkheads are distinguished by the addition of a word or words, explaining the location, use kind of material or method of fabrication, such as fore peak, longitudinal, transverse, watertight, wire mesh, pilaster, etc. Bulkheads which contribute to the strength and seaworthiness of a vessel are called strength bulkheads, those which are essential to the watertight subdivision are watertight or oiltight bulkheads, and gastight and fumetight bulkheads serve to prevent gas or fumes from leaving or entering certain parts of a vessel. Never called a wall.

BULKHEAD, AFTER PEAK—A term applied to the first transverse bulkhead forward of the stern post. This bulkhead forms the forward boundary of the after-peak tank and should be made watertight.

BULKHEAD, COLLISION—The foremost transverse watertight bulkhead in a ship which extends from the bottom of the hold to the freeboard deck. It is designed to keep water out of the forward hold in case of collision damage. Usually, this is the fore peak bulkhead at the after end of the fore peak tank.

BULKHEAD, JOINER—Wood or light metal bulkheads serving to bound staterooms, offices, etc. and not contributing to the ship's strength. Included under this head are corrugated metal, pressed panel, pilaster, aluminum, stainless steel, etc.

BULKHEAD STIFFENER—Members attached to the plating of a bulkhead for the purpose of holding it in a plane when pressure is applied to one side. The stiffener is generally vertical, but horizontal stiffeners are used and both are found on same bulkheads. The most efficient stiffener is a T section; flat bars, angles, channels, zees, H and I sections are commonly used.

BULKHEAD, SWASH—A strongly built, nontight bulkhead placed in oil or water tanks to slow down the motion of the fluid set up by the motion of the ship.

BULKHEAD, WIRE MESH—A partition or enclosure bulkhead, used largely in store rooms, shops, etc., made of wire mesh panels.

BUOYANCY—Ability to float; the supporting effort exerted by a liquid (usually water) upon the surface of a body, wholly or partially immersed in it.

BUOYANCY, RESERVE—The floating or buoyant power of the unsubmerged portion of the hull of a vessel. Usually referred to a specific condition of loading.

BYPASS—To divert the flow of gas or liquid. Also, the line that diverts the flow.

CALIBRATION—(1) The operation of making an adjustment or marking a scale so that the readings of an instrument conform to an accepted standard. (2) The checking of readings by comparison with an accepted standard.

CALKING—The operation of jamming material into the contact area to make a joint watertight or oiltight.

CASUALTY—An event or series of events in progress during which equipment damage and/or personnel injury has already occurred. The nature and speed of these events are such that proper and correct procedural steps will only serve to limit equipment damage and/or personnel injury.

CAULK—The act of stuffing the seams between wooden planking with oakum for watertightness.

CENTERLINE—(1) Lines that indicate the center of a circle, arc, or any symmetrical object; consist of alternate long and short dashes evenly spaced. (2) The middle line of the ship from stem to stern as shown in any waterline view. (3) Well-defined knife or gage line placed upon the work to serve as a basis from which dimensions are to be measured.

CENTER OF BUOYANCY—The geometric center of gravity of the immersed volume of the displacement or of the displaced water, determined solely by the shape of the underwater body of the ship. It is calculated for both the longitudinal location, forward or aft of the middle perpendicular, and the vertical location above the base line or below the designed waterline.

CENTER OF FLOTATION—The geometric center of gravity of the water plane at which the vessel floats, forward or aft of the middle perpendicular. It is that point about which a vessel rotates longitudinally when actuated by an external force without change in displacement.

CENTER OF LATERAL RESISTANCE—The point through which a single force could act and produce an effort equal to the lateral resistance of the vessel. It is ordinarily assumed to be coincident with the center of gravity of the immersed central longitudinal plane.

CENTER OF PRESSURE—The point in a sail or an immersed plane surface at which the resultant of the combined pressure force acts. Also center of effort.

CENTIGRADE (CELSIUS)—On the centigrade thermometer, the interval between the freezing point and the boiling point of water is divided into 100 parts or degrees, so that 0°C. corresponds to 32°F., and 100°C. to 212°F.

CENTRAL CONTROL STATION (CCS)—The main operating station from which a majority of the engineering plant machinery can be controlled and monitored.

CIRCUIT BREAKER (CB)—An automatic protective device that, under abnormal conditions, will open a current-carrying circuit.

CLAMP—A metal fitting used to grip and hold wire ropes. Two or more may be used to connect two ropes in lieu of a short splice or in turning in an eye. Also a device, generally operated by hand, for holding two or more pieces of material together, usually called a "C" clamp. In small boats, the main longitudinal strength member at the side and under the deck beams in decked-over boats, and at the gunwale in open boats.

CLINOMETER—An instrument used for indicating the angle of roll or pitch of a vessel.

COAMING—Bulwark around a hatch opening.

COAMING, BULKHEAD—A term applied to the top and bottom strakes of bulkheads, which are usually made thicker than the remainder of the plating and which act as girder web plates in helping to support the adjacent structure.

COAMING, HATCH—A frame bounding a hatch for the purpose of stiffening the edges of the opening and forming the support for the covers. In a steel ship generally consists of a strake of strong vertical plating completely bounding the edges of a deck opening.

COAMING, HOUSE—A term applied to the narrow vertical plates bounding the top and bottom of a deck house, made somewhat thicker than the side plating and forming a frame for the base and top of the house. Also applied to the heavy timbers which form the foundation of a wood deck house.

COAMING, MANHOLE—The frame worked around a manhole to stiffen the edges of the plating around the opening and to provide a support for the cover.

CO_2 INDICATOR—An instrument designed to reveal the presence of carbon dioxide.

COLLISION BULKHEAD—A bulkhead, stronger than normal, located forward to control flooding in the event of a head-on collision.

COMBATANT SHIP—A ship whose primary mission is combat.

COMBUSTIBLE—A material that can burn.

COMPARTMENT—A subdivision of space or room in a ship.

COMPLETE DECK—Any deck which extends the length of a ship and from side to side.

CONFLAGRATION—Large fire with a central column of rising heated air and burned gases, featuring an extended wall of fire moving to leeward in front of a strong wind.

CONSTRUCTION LINES—Lightly drawn lines used in the preliminary layout of a drawing.

CUTOUT VALVE—A valve that is intended normally to be fully open or fully closed.

CUTWATER—The forward edge of the stem at or near the water line is called the cutwater.

DAMAGE CONTROL CONSOLE (DCC)—Located in CCS and provides monitoring for hazardous (fire, high bilge levels, and so forth) conditions. It also monitors the ship's firemain and can control the fire pumps.

DCT—Disaster control team.

DEBALLASTING—The process by which salt water is emptied from tanks to protect the ship from underwater damage and to increase its stability.

DECAY, RADIOACTIVE—Spontaneous and gradual disintegration of one atom or element into another.

DECK—A deck in a ship corresponds to a floor in a building. It is the plating, planking, or covering of any tier of beams above the inner bottom forming a floor, either in the hull or superstructure of a ship. Decks are designated by their location as upper deck, main deck, etc., and forward lower deck, after superstructure deck, etc. The after portion of a weather deck was formerly known as the quarter deck and on warships is allotted to the use of the officers.

DECK BOLT—A special type of bolt used to secure the planks of a wood deck to the frames or deck plating.

DECK, BULKHEAD—The uppermost continuous deck to which all main transverse bulkheads are carried. This deck should be watertight to prevent flooding adjacent compartments if a compartment is holed.

DECK, FREEBOARD—The deck to which the classification societies require the vessel's freeboard to be measured. Usually the upper strength deck.

DECK HEIGHTS—The vertical distance between the molded lines of two adjacent decks.

DECK HOUSE—A term applied to a partial superstructure that does not extend from side to side of a vessel as do the bridge, poop, and forecastle.

DECK PLATING—A term applied to the steel plating of a deck.

DECK STRINGER—The strip of deck plating that runs along the outer edge of a deck.

DEEP TANKS—Tanks extending from the bottom or inner bottom of a vessel up to or higher than the lowest deck. They are fitted with hatches so that they may be used for cargo when the vessel is loaded in lieu of the ballast water carried when the vessel is "light." They are placed at either end or both ends of the machinery space as deemed necessary.

DEPTH MOLDED—The vertical distance from the molded base line to the top of the uppermost strength deck beam at side, measured and midlength of the vessel.

DESIGNER'S WATERLINE—The intended position of the water surface against the hull.

DESTROYER—A naval vessel of moderate displacement and high speed, armed with rapid-fire guns, and torpedo tubes or missiles, used for a protection to capital ships or anti-submarine vessel. Larger vessels of this type are called light cruisers, and smaller vessels are called frigates.

DIAGONAL LINE—A line cutting the body plan diagonally from the frames to the middle line in the loft lay-out and usually a mean normal to a group of frames of similar curvature, representing a plane introduced for line fairing purposes.

DISPLACEMENT CURVES—Curves drawn to give the displacement of the vessel at varying drafts. Usually these curves are drawn to show the displacement in either salt or freshwater, or in both, the saltwater curves being based on 35 cubic feet to a ton and freshwater curves on 36 cubic feet to a ton. Corrections are made from these basic standards for variable density of the water.

DISPLACEMENT, DESIGNED—The displacement of a vessel when floating at her designed draft.

DISPLACEMENT, FULL LOAD—The displacement of a vessel when floating at her greatest allowable draft as established by the classification societies. In warships an arbitrary full-load condition is established.

DISPLACEMENT, LIGHT—The displacement of the vessel complete with all items of outfit, equipment, and machinery on board but excluding all cargo, fuel, water, stores, passengers, dunnage, and the crew and their effects. Naval and merchant practice differs in one particular; in the former the machinery weights are dry, while the merchant light condition includes the water and oil in the machinery with boilers at steaming level.

DOG—(1) A lever, or bolt and screws, used for securing a watertight door, hatch, or port. (2) A device used to secure stock to the rotating parts of a lathe.

DOGDOWN—To set the dogs on a watertight door.

DOGGING—(1) The act of securing a hatch or cover with dogs. (2) The act of dividing a 4-hour watch into two shorter watches. See also "dog down."

DOOR FRAME—The frame surrounding a door opening on which the door seats.

DOOR, JOINER—A light door fitted to staterooms and quarters where air and watertightness is not required. Made of wood, light metal, and metal-covered wood. Metal joiner doors with pressed panels are extensively used.

DOOR, WATERTIGHT—A door so constructed that, when closed, it will prevent water under pressure from passing through. A common type consists of a steel plate, around the edges of which a frame or angle bar is fitted, having a strip of rubber attached to the reverse side of the flange that is fastened to the door plate. The strip of rubber is compressed against the toe of the flange of an angle-iron door frame by dogs or clamps.

DOUBLE BOTTOM—A term applied to the space between the inner and outer skins of a vessel called respectively the "inner bottom" and "shell," usually extending from bilge to bilge and for nearly the whole length of the vessel fore and aft, and subdivided into water or oiltight compartments. In some cases, and generally in warships, the inner bottom is carried above the bilges to a deck at or near the waterline. Where more than one inner skin is fitted, as is sometimes the case, the two spaces are known as the "lower bottom tank" or "void" and the "upper bottom tank." The outer skin is known as the "shell," the skin next to it as the "lower inner bottom," and the third skin as the "upper inner bottom."

DRAFT—(1) The depth of the vessel below the waterline measured vertically to the lowest part of the hull, propellers, or other reference point. When measured to the lowest projecting portion of the vessel, it is called the "draft, extreme", when measured at the bow; it is called "draft, forward"; and when measured at the stern, the "draft, aft"; the average of the draft, forward, and the draft, aft, is the "draft, mean," and the mean draft when in full load condition is the "draft, load." (2) (Foundry term) The angle of slant tending away from the line of parting given to those surfaces of a pattern which would lie in the direction in which the pattern or its component parts are drawn from the sand.

DRAFT MARKS—The numbers which are placed on each side of a vessel near the bow and stern, and often also amidships, to indicate the distance from the number to the bottom of the keel or a fixed reference point. These numbers are six inches high, are spaced twelve inches bottom to bottom vertically, and are located as close to the bow and stern as possible.

DRAG—(1) The designed excess of draft, aft, over that forward, measured from the designer's waterline. The drag is constant and should not be confused with trim. (2) Resistance to ships forward motion caused by skin friction. (3) Foundry term; The bottom section of a molder's flask.

EDUCTOR—A mixing tube (jet pump) that is used in the GTM exhaust system. It is physically positioned at the top of the stack so the gas flow from the GTM exhaust nozzles will draw outside air into the exhaust steam as it enters the mixing tube. It may also be a liquid pump used to dewater bilges and tanks.

EMERGENCY—An event or series of events in progress which will cause damage to equipment unless immediate, timely and correct procedural steps are taken.

EVEN KEEL—When a boat rides on an even keel, its plane of flotation is either coincident with or parallel to the designed waterline.

EYE BOLT—A bolt having either a head looped to form a worked eye or a solid head with a hole drilled through it forming a shackle eye.

FAHRENHEIT SCALE—A temperature scale, at which, under atmospheric pressure, the boiling point is 212° and the ice point is 32° above zero.

FANTAIL—(1) The overhanging stern section of vessels which have round or elliptical after endings to uppermost decks and which extend well abaft the after perpendicular. (2) The after end of the main deck.

FIREMAIN SYSTEM—A seawater system provided for the primary purpose of extinguishing shipboard fires and controlling CBR decontamination. The firemain has a secondary function to supply seawater to other systems such as equipment cooling and waste disposal.

FLAMMABLE—A combustible material that burns easily, intensely or quickly.

FLOOD—(1) To fill a space with water; (2) a rising tide.

FLOODABLE LENGTH—The length of vessel which may be flooded without sinking her below her safety or margin line. The value of the floodable length of a given vessel varies from point to point throughout her length due to change in form. Similarly at a given point it varies from time to time, depending upon the condition of loading and the permeability of the cargo.

FORECASTLE—A short structure at the forward end of a vessel formed by carrying up the ship's shell plating a deck height above the level of her uppermost complete fleck and fitting a deck over the length of this structure. The name applied to the crew's quarters on a merchant ship when they are in the forepart of the vessel. (Pronounced foksul.)

FORE—A term used in indicating portions or that part of a ship at or adjacent to the bow. Also applied to that portion and parts of the ship lying between the midship section and stem; as forebody, forehold, foremast and forward.

FORE AND AFT—The entire length of a ship, as in "Sweep down fore and aft."

FORWARD PERPENDICULAR—A line perpendicular to the baseline and intersecting the forward side of the stem at the designed waterline.

FRAME—(1) A term generally used to designate one of the transverse ribs that make up the skeleton of a ship. The frames act as stiffeners, holding the outside plating in shape and maintaining the transverse form of the ship. (2) The athwartship strength member of a ship's hull.

FRAME LINES—(1) Molded lines of a vessel as laid out on the mold loft floor for each frame, showing the form and position of the frames. (2) The outline of transverse plane sections of a hull.

FRAME SPACING—The fore-and-aft distances between frames, heel to heel.

FREEBOARD—The vertical distance from the waterline to the top of the weather deck at side.

GAGE, DRAFT—An installation comprising a graduated glass tube, connected at the bottom end with the sea and with the top end open to the air, on which the draft of the vessel is shown by the level of the water in the tube.

GAUGE PRESSURE—Pressure which is measured using atmospheric pressure for zero reference.

GENERAL QUARTERS—The condition of full readiness for battle.

GUNWALE—A term applied to the line where a weather deck stringer intersects the shell. The upper edge of the side of an open boat. The upper edge of the sides of a ship. (Pronounced gunnel.)

HALF DECK—A partial deck below the main deck.

HATCH, HATCHWAY—An opening in a deck through which cargo may be handled, machinery or boilers installed or removed, and access obtained to the decks and holds below. Hatch is properly a cover to a hatchway but is often used as a synonym for hatchway.

HATCHWAY TRUNK—A term applied to the space between a lower deck hatchway and the hatchway or hatchway immediately above it when enclosed by a casing. A trunk may be either watertight or nonwatertight.

HEEL—(1) The convex intersection point or corner of the web and flange of a bar. (2) The inclination of a ship to one side, caused by wind or wave action or by shifting weights onboard.

HOLD—The space or compartment between the lowermost deck and the bottom of the ship, or top of the inner bottom if one is fitted. The space below decks allotted for the stowage of cargo.

HULL—(1) The framework of a vessel, together with all decks, deck houses, and the inside and outside plating or planking, but exclusive of masts, yards, rigging, and all outfit or equipment. (2) The shell, or plating, of a ship from keel to gunwale.

INBOARD—Toward the center; within the vessel's shell and below the weather decks.

INERT GAS—A gas which has no active chemical properties.

INITIAL STABILITY—The stability of a vessel in the upright position or at small angles of inclination. It is usually represented by the metacentric height.

INNER BOTTOM—A term applied to the inner skin or tank top plating. The plating over the double bottom.

KEEL—A center-line strength member running fore and aft along the bottom of a ship and often referred to as the backbone. It is composed either of long bars or timbers scarfed at their ends or by flat plates connected together by riveting or welding.

LENGTH BETWEEN PERPENDICULARS—The length of a ship measured from the forward side of the stem to the aft side of the stern post at the height of the designed water line. In naval practice, the total length on the designed water line.

LENGTH OVER ALL—The length of a ship measured from the foremost point of the stem to the aftermost part of the stern.

LIST—The deviation of a vessel from the upright position, due to flooding, shifting of cargo, or other cause of unbalance.

LONGITUDINALS—A term applied to the fore-and-aft girders in the bottom of a ship. These girders are usually; made up from plates and shapes and are sometimes intercoastal and sometimes continuous.

MAGAZINES—Spaces or compartments devoted to the stowage of ammunition. Often specifically applied to compartments for the stowage of powder as a distinction from shell stowage spaces.

MAIN DECK—The principal deck of the hull, usually the highest extending from stem to stern and providing strength to the main hull.

MANHOLE—A round or oval hole cut in decks, tanks, boilers, etc., for the purpose of providing access.

MARGIN PLANK—A plank forming the boundary or margin of the deck planking.

MARGIN PLATE—The outer boundary of the inner bottom, connecting it to the shell plating at the bilge.

MIDSHIP BEAM—A deck beam of the transverse frame located at the midpoint between the forward and after perpendiculars. Also applicable to the transverse dimension of the hull at the same point.

MIDSHIP FRAME—The frame located at the midpoint between the perpendiculars.

MIDSHIPS—Same as Amidships.

MIDSHIP SECTION—The vertical transverse section located at the midpoint between the forward and after perpendiculars. Usually this is the largest section of the ship in area. Also, applied to a drawing showing the contour of the midship frame upon which is depicted all the structural members at that point with information as to their size and longitudinal extent.

NAVAL STANDARDS—Requirements for advancement for all ratings including military conduct, naval organization, military justice, security, and watchstanding.

OAKUM—A substance made from soft vegetable fibre such as hemp and jute impregnated with pine tar. It is principally used for calking the planking on wood decks of steel vessels and for calking all the planking on wood ships where watertightness is desired. It is also used for calking around pipes.

OCCUPATIONAL STANDARDS—Requirements that are directly related to the work of each rating.

ONE-LINE SCHEMATIC—Drawing of a system using only one line to show the tie-in of various components; for example, the three conductors needed to transmit three-phase power are represented by a single line.

ONE-LINE SKETCH—Drawing using one line to outline the general relationship of various components to each other.

OVERHEAD—The underside of a deck forms the overhead of the compartment next below. Never called a ceiling.

PEAK TANK—Compartments at the extreme fore and aft ends of the ship for any use either as void spaces or as trimming tanks. When used for the latter purpose water is introduced to change the trim of the vessel.

PERPENDICULAR—Vertical lines extending through the outlines of the hull ends and the designer's waterline.

PITCHING—The alternate rising and falling motion of a vessel's bow in a nearly vertical plane as she meets the crests and troughs of the waves.

PLAT—A map or plan view of a lot showing principal features, boundaries, and location of structures.

PLATFORM—A partial deck.

PLATING, SHELL—The plating forming the outer skin of a vessel. In addition to constituting a watertight envelope to the hull, it contributes largely to the strength of the vessel.

PLIMSOLL MARK—A mark painted on the sides of a vessel designating the depth to which the vessel may, under the maritime laws, be loaded in different bodies of water during various seasons of the year.

POOP—The structure or raised deck after end of a vessel.

POUNDS PER SQUARE INCH (psi)—Unit of pressure.

POUNDS PER SQUARE INCH GAUGE (psig)—Unit of pressure.

PRESSURE—Pressure is force per unit of area, usually expressed as psi.

PROTECTED COMPARTMENT—A compartment with a fixed (total flooding) carbon dioxide system installed.

PYROTECHNICS—(1) Ammunition containing chemicals that produce smoke or a brilliant light in burning; used for signaling or for illumination. (2) Flares, rockets, powder, etc., used for giving signals or for illumination, more generally used as distress signals.

RADIATION—Transfer of heat in the form of waves similar to light and radio waves, without physical contact between the emitting and the receiving regions.

REFERENCE PLANE—On a drawing, the normal plane from which all information is referenced.

RISER—(1) An opening made from the mold cavity to the top of the mold in which the metal will rise during the pouring operation and which may later act as a feeder for the prevention of porosity in the casting due to shrinkage. (2) A reservoir designed to supply molten metal to compensate for shrinkage of a casting during solidification. (3) A pipe leading from the firemain to fireplugs on upper deck levels. (4) A vertical pipe leading off a large one; for example, firemain riser. (5) A vertical casualty control cable leading from deck to another. (6) The upright board of a stair. A pipe extending vertically and having side branches. (7) A distribution pipe extending vertically.

RIVET—A metal pin used for connecting two or more pieces of material by inserting it into holes punched or drilled in the pieces and upsetting one or both ends. The end that bears a finished shape is called the head and the end upon which some operation is performed after its insertion is called the point. Small rivets are "driven cold," i.e., without heating, and large ones are heated so that points may be formed by hammering.

SCUTTLE—(1) A small opening, usually circular in shape and generally fitted in decks to provide access. Often termed escape scuttles, and when fitted with means whereby the covers can be removed quickly to permit exit are called quick acting scuttles. (2) Round, watertight opening in a hatch. (3) The act of deliberately sinking a vessel.

SECOND DECK—First complete deck below the main deck.

SECTION LINES—Thin, diagonal lines used to indicate the surface of an imaginary cut in an object.

SELECTOR SWITCH—Usually a rotary-type switch with more than two line connections. The selector switch permits the connection of a permanently connected handset to any other circuit selected—that is, wired in, by means of a jack outlet. In some stations, where only two circuits are involved, a double-throw toggle switch is sufficient.

SHOLE—A small piece of timber or plank placed under the heel of a shore.

SHORE—(1) The land in general, but usually refers to that part adjacent to the water; (2) a timber used in damage control to brace bulkheads and decks.

SOFT PATCH—A temporary plate put on over a break or hole and secured with tap bolts. It is made watertight with a gasket such as canvas saturated in red lead.

STABILITY, RANGE OF—The number of degrees through which a vessel rolls or lists before losing stability.

STERN—The after end of a vessel; the farthest distant part from the bow.

STIFFENER—An angle bar, T-bar, channel, etc., used to stiffen plating of a bulkhead, etc.

STRUCTURAL BULKHEAD—Transverse strength bulkhead that forms a watertight boundary.

STUFFING TUBE—A packed tube that makes a watertight fitting for a cable or small pipe passing through a bulkhead.

TOGGLE PIN—A pin having a shoulder and an eye worked on one end, called the head, and whose other end, called the point, has its extremity hinged in an unbalanced manner so that after being placed through a hole it forms a T-shaped locking device to keep the pin from working out or being withdrawn without first bringing the hinged portion into line with the shaft of the pin.

TRANSVERSE—At right angles to the ship's fore-and-aft centerline.

TRIM—The arithmetical sum of the drafts forward and aft above and below the mean waterline. The angle of trim is the angle between the plane of flotation and the mean waterline plane. A vessel "rims by the head" or "trims by the stern" when the vessel inclines forward or aft so that her plane of flotation is not coincident with her mean waterline plane. See DRAG.

WATERLINE—(1) A term used to describe a line drawn parallel to the molded baseline and at a certain height above it, as the 10-foot waterline. It represents a plane parallel to the surface of the water when the vessel is floating on an even keel, i.e., without trim. In the body plane and the sheer plan it is a straight line, but in the plan view of the lines it shows the contour of the hull line at the given distance above the base line. Used also to describe the line of intersection of the surface of the water with the hull of the ship at any draft and any condition of trim. (2) The outline of a horizontal longitudinal section of a ship's hull.

WATERTIGHT COMPARTMENT—A space or compartment within a ship having its top, bottom, and sides constructed in such a manner as to prevent the leakage of water into or from the space unless the compartment is ruptured.

WATERTIGHT INTEGRITY—The degree or quality of watertightness.

WEATHER DECK—A term applied to the upper, awning, shade, or shelter deck, or to the uppermost continuous deck, exclusive of forecastle, bridge, or poop, that is exposed to the weather.

WEDGES—Wood or metal pieces shaped in the form of a sharp V, used for driving up or for separating work. They are used in launching to raise the vessel from the keel blocks and thus transfer the load to the cradle and the sliding ways.

WEIGHT—The force of gravity exerted on an object.

WHEATSTONE BRIDGE—A device for the measurement of electrical resistance.

WINDWARD—Toward the direction from which the wind is blowing.

WIREWAYS—Passageways between decks and on the overheads of compartments that contain electric cables.

WYE GATE—A fitting with two separately controlled hose fittings, designed to connect to an outlet.

ZONE NUMBERS—Numbers and letters on the border of a drawing to provide reference points to aid in indicating or locating specific points on the drawing.

APPENDIX II

CBR TERMINOLOGY

ABSORBED DOSE/(DOSE)—The actual amount of ionizing radiation energy absorbed by body tissues per gram of tissues; expressed in rads. In this manual, the concept of exposure is used primarily.

ABSORBED DOSE RATE—The actual rate at which ionizing radiation energy is absorbed by body tissues, expressed in rads/hr.

ACCEPTABLE DOSE—Radiation dose considered acceptable by command for the conditions of a single contaminating nuclear attack. Equal to or less than maximum permissible dose.

ADJUSTMENT OF OPERATING PROCEDURES—A type of radiological countermeasure used to reduce exposure of mission personnel and thus permit an earlier mission entry time. Also used to regulate exposure of recovery personnel. These adjustments include reduction in hours worked per day or per week, increased number of shifts per day, and rotation of personnel between locations of high and low exposure rates.

AIRBURST—A nuclear explosion sufficiently high in the air that the fireball does not significantly interact with the ground or water. This type of burst does not cause significant fallout.

ALPHA RADIATION—Positively charged particles that are identical with the nuclei of helium atoms. Alpha particles are completely absorbed in a few inches of air and cannot penetrate clothing or skin. Hazards from alpha particles are insignificant to this report.

APPLIED SHIELDING—Material, for example, sandbags, earth, or concrete blocks, added to a building or around a work area during the operational recovery phase to reduce the gamma-radiation exposure rate. (See SHIELDING.)

BETA RADIATION—High speed electrons. Beta particles can penetrate a few feet in air and are absorbed by a small thickness of material. The hazard from beta particles is negligible from the standpoint of this report EXCEPT for the case where fallout material directly contaminates the skin or clothing of recovery personnel.

BIOLOGICAL RECOVERY—The limited ability of the human body to repair the injury caused by gamma radiation. Biological recovery does not apply to late effects, which are independent of the time period over which exposure is received.

BLAST DAMAGE—Damage caused by the air-blast wave of a nuclear-weapon explosion. Damage from ground- or water-transmitted overpressures is usually called shock damage.

BUFFER ZONE—A reclaimed strip around the staging area or the vital area required to obtain the desired reduction in radiation-field exposure rates in either area.

BULLDOZING—A reclamation method, using a bulldozer, in which several inches of the top layer of the contaminated soil are scraped off and moved from the area.

CASUALTIES—Personnel unavailable for duty because of radiation injury.

CLEAN—Not contaminated; i.e., not covered by or contaminated with significant amounts of radioactive material.

CONTAMINANT—See CONTAMINATION.

CONTAMINATED AREA—Any surface on which fallout has deposited.

CONTAMINATING NUCLEAR ATTACK—A nuclear-weapon explosion that produces fallout contamination in militarily significant amounts. Surface and subsurface bursts may produce such contamination.

CONTAMINATION—Dirt particles or water droplets carrying radioactive materials. In this manual, only dry contamination (dirt) is considered. CONTAMINATION and CONTAMINANT are often used interchangeably.

CONTROL CENTER—A location, usually well-protected, from which defense operations are directed and coordinated.

CONTROL POINT—Location at which authorized personnel control the movements of personnel and material in and out of a contaminated area. Control points are usually located at the edge of the staging area and area adjacent to personnel-decontamination and material-decontamination facilities, such as the decontamination station.

COUNTERMEASURE—A procedure such as decontamination, use of applied or natural shielding, adjustment of operating procedures, etc. which serves to decrease the effect of radioactive fallout in producing casualties. See RADIOLOGICAL COUNTERMEASURES.

DCT—Disaster control team.

DECAY, RADIOACTIVE—Spontaneous and gradual disintegration of one atom or element into another.

DECONTAMINATION—Removal of contamination from a surface, particularly from a paved surface, building surface, equipment, or personnel. (Decontamination is a sub-category of reclamation.) See RECLAMATION.

DECONTAMINATION STATION, PERSONNEL—A building or area, adjacent to the control point of the staging area, in which a person who has been exposed to contamination may (1) have his body and clothing monitored for radioactivity, (2) remove radioactivity from his body by showering, and (3) have issued to him clean clothing to replace any contaminated articles. The decontamination station may also be used to brief work crews entering the contaminated area. It is generally located on the main access road at or just inside the staging area.

DOSE—See ABSORBED DOSE.

DOSE LIMIT—See EXPOSURE LIMIT.

DOSE RATE—See EXPOSURE RATE.

DOSIMETER—A portable individual radiac instrument for indicating the amount of gamma radiation to which a person has been exposed; i.e., an instrument which measures exposure. (Dosimeters which actually measure DOSE in rads are not in fact generally available. However, to a good first approximation, a fallout exposure of 1 roentgen results in a dose of 1 rad.)

EARLY EFFECTS—Casualty effects noticeable during exposure or within hours after exposure to gamma radiation.

EMERGENCY DOSE—The dose received by personnel while in shelter during the emergency phase. Also called SHELTER DOSE.

EMERGENCY PHASE—The first phase of radiological defense. Covers the time period of peak radiation hazard from warning or time of attack to the beginning of the operational recovery phase. The end of the emergency phase may lie between several days and four weeks after attack. Adequate shelter is the primary countermeasure during this phase.

ENTRY TIME—The time, measured from the time of burst, at which personnel enter a radiation field to perform an action, such as recovery work or mission resumption. It may have a modifying adjective, such as recovery entry time, or mission entry time (MET). The time at which a group leaves the radiation field, measured from burst time, is the exit time. The exit time minus the entry time is the staytime or exposure period.

ESSENTIAL FUNCTIONS—The functions and associated facilities that are vital to the post-attack mission as defined by Command. They are located in the vital area.

EXIT TIME—Defined under ENTRY TIME.

EXPOSURE—The amount of gamma radiation (measured in roentgens) to which a person has been exposed. In this manual, all exposures are referenced to a height 3 ft above the ground. cf. EXPOSURE RATE: DOSE.

EXPOSURE LIMIT—For recovery planning purposes, the maximum exposure that Command decides recovery personnel can be exposed to during the recovery operations. In using this manual, one of the following values may be selected: 25 r, 50 r, 100 r, or 200 r. Also, the maximum exposure that Command decides mission personnel can be exposed to during a specified interval from the time of burst to the MET. For conservative planning using this manual, the exposure limit (lower limit) for mission personnel is 110 r in any one month or longer period (during the mission duration.) For the upper limit, the corresponding values are 190 r/day, 250 r/wk, or 500 r/month or longer period.

EXPOSURE MULTIPLIER—A constant number associated with a given time after attack that, when multiplied by the standard exposure rate, gives an estimate of the exposure to unprotected personnel in the open from the time of attack to that time.

EXPOSURE PERIOD—See STAYTIME.

EXPOSURE RATE—The time rate of gamma-radiation-produced ionization, as measured in air in units of roentgens/hr; the exposure rate is a measure of the strength of a gamma-ray field at a given time. Exposure rate multiplied by staytime in the radiation field is the exposure.

EXTERNAL HAZARD—Hazard caused by radiation coming from a source outside the body. The only important external hazard is gamma radiation. Beta radiation is a limited external hazard causing burns only on unprotected, or lightly protected, skin resulting essentially only from skin or clothing contamination. Alpha radiation is not an external hazard.

FALLOUT—The radioactive contamination produced by a nuclear-weapon explosion and deposited on the earth's surface after falling from the nuclear cloud.

FALLOUT ARRIVAL—The time after burst when radioactive fallout starts depositing on a surface.

FALLOUT CESSATION—The time after burst when radioactive fallout stops depositing on a surface.

FALLOUT CONTOURS—The distribution of fallout depicted in terms of standard-exposure-rate contours or exposure contours.

FALLOUT PERIOD—The time interval from fallout arrival to fallout cessation.

FILLING—A reclamation method in which uncontaminated dirt fill is used to cover a contaminated area, thus reducing exposure rate above the surface.

FILM BADGE—A photographic dosimeter worn on the body to indicate gamma exposure. Badges may also be designed to indicate beta does.

FINAL RECOVERY PHASE—The third and last phase of radiological defense, starting at the MET and covering the time period after gamma radiation ceases to be a significant hazard and extending up to the time period when normal operations are resumed. Contamination control is the primary countermeasure.

FIREBALL—The luminous, intensely hot mass of gas and fission products formed at the time of a nuclear explosion. It emits initial nuclear radiation, thermal radiation, and brilliant light.

FIREHOSING—A decontamination method by which a strong stream of water is applied to a contaminated surface with a firehose and nozzle to remove the contaminant.

FISSION PRODUCTS—Radioactive elements resulting from nuclear fission at the instant of a nuclear explosion.

GAMMA RADIATION—High-energy electromagnetic radiation similar to X-rays. Gamma rays can penetrate hundreds of feet of air, and can never be completely absorbed by a barrier. However, they can be reduced to harmless exposure-rate level by a sufficient thickness of material.

GRADING—A reclamation method that removes an upper layer of contaminated soil.

GROUND ZERO (GZ)—The point on the ground surface that is vertically beneath or above the point at which a nuclear explosion occurs.

HALF LIFE—Time required for half of an original number of radioactive atoms to undergo decay. (See DECAY, RADIOACTIVE.)

HIGH-ALTITUDE BURST—The bomb explodes above 100,000 feet.

HOTSPOT—A local area where the exposure rate of the radiation field is above the average exposure rate of the surrounding area. Hotspots may result from variations in fallout deposition, variations in the wind pattern around structures, piling up of contamination in natural collecting locations, poor drainage, spillage during reclamation, high surface contaminability, etc.

INITIAL NUCLEAR RADIATION—Nuclear radiation (essentially neutrons and gamma rays) emitted from the fireball and the cloud column during the first minute after a nuclear explosion. The time limit of 1 minute is set, somewhat arbitrarily, as that required for the source of part of the radiations (fission products, etc., in the radioactive cloud) to attain such a height that only insignificant amounts reach the Earth's surface. (See RESIDUAL NUCLEAR RADIATION.)

INSTALLATION—A fixed military facility, together with its buildings, equipment, subsidiary facilities.

ISOTOPE—Atoms of an element having the same atomic number but different mass numbers are called isotopes.

KILOTON (KT)—A unit of measurement of nuclear-weapon yield, roughly equivalent to the explosive energy released by 1,000 tons of TNT.

LATE EFFECTS—Biological effects noticeable months to years after receiving radiation exposure: for example, leukemia, cancer, anemia, and general shortening of the life span. Late effects are dependent on the total exposure received and are probably independent of the time period over which the exposure if received. Biological recovery does not apply to late effects.

MEGATON (MT)—A unit of measurement of nuclear-weapon yield equivalent of 1,000 kilotons.

MET—See MISSION ENTRY TIME.

MICRO-ORGANISM—Minute living organisms capable of carrying on all functions of life, including growth and reproduction.

MISSION—An installation's mission consists of all essential operations and functions. The mission does not include the special recovery efforts required after contaminating nuclear attack.

MISSION DURATION—The length of time that the installation's mission must be performed after radiological recovery. Taken in this manual to be two years.

MISSION ENTRY TIME (MET)—The time, measured from the time of burst, at which mission personnel can enter the vital area of the installation to resume the essential functions without receiving excessive radiation exposure.

MISSION PERSONNEL—Personnel who are to perform the essential functions of the installation after recovery has been achieved.

MOLECULE—The smallest particle of any substance which can exist free and still exhibit all properties of the substance.

MONITOR—A person trained to measure radiation-field exposure rates and the amount of contamination on personnel and equipment by using suitable radiac instruments.

MONITORING—Locating radioactive contamination and measuring its radiation exposure rate by means of radiac instruments.

MPE—Maximum permissible exposure. Amount of radiation or contamination established as the maximum to which personnel may be exposed under wartime conditions.

NUCLEAR CLOUD—The characteristic cloud of a nuclear explosion formed upon cooling of the fireball. It contains the fission products of the explosion and is highly radioactive.

NUCLEAR RADIATIONS—The radiations emitted from the nuclei of the radioactive atoms in the contaminant or during fission. These may include alpha, beta, gamma, and neutron radiations. Gamma radiation is nuclear radiation of primary significance to this manual (beta radiation is a hazard only if skin or clothes become contaminated).

OPERATIONAL RECOVERY MEASURES—Radiological-defense actions taken in the operational recovery phase. The objective is the radiological recovery of the essential functions of the installation in order to resume the mission.

OPERATIONAL RECOVERY PHASE—The time-phase of action that immediately follows the emergency phase. This phase starts at the earliest practicable time and may last for weeks or months. In this phase, the military organization will have the objective of recovering the use of the essential functions of the installation as quickly as possible in order to resume the mission. This phase is the time period of primary concern in this manual.

PF—See PROTECTION FACTOR.

PLOWING—A reclamation method. The plow turns the contaminated soil over, mixes contaminant with the soil, buries much of the contaminated soil under fresh soil, and thereby provides some earth shielding against the contaminant.

PROTECTION FACTOR (PF)—The ratio of the amount of radiation from fallout that would be received by an unprotected person outside a fallout shelter to the amount that he would receive inside that shelter. The PF, used exclusively as a measure of shelter effectiveness, is usually distinguished from the RN which is used exclusively as a measure of radiological countermeasure effectiveness. The PF may thus be a ratio of the outside to inside exposure rates or outside to inside exposures.

PROTECTIVE CLOTHING—Clothing worn to prevent radioactive contaminant from contacting the skin. Usually, such clothing is put on before entry into a contaminated area and is removed when leaving the area via the change station.

PROTECTIVE EQUIPMENT—Devices, such as masks, for the protection of personnel against radiation hazards.

RAD—Absorbed dose of radiation. For certain energies, 1 roentgen gives rise to about 1 rad absorbed dose in tissue.

RADIAC INSTRUMENTS—Devices used to measure radiation exposure rate or exposure.

RADIATION—The subatomic rays or particles emitted by radioactive contamination, such as gamma rays, alpha particles, and beta particles. Also referred to as nuclear radiation, ionizing radiation, and invisible radiation. In nonnuclear radiation is meant, the term is always used with an adjective; for example, thermal radiation and visible radiation.

RADIATION DOSE—See ABSORBED DOSE.

RADIATION EXPOSURE RATE—See EXPOSURE RATE.

RADIATION FIELD—The combined effect at a given point of all the gamma radiation reaching that point. (See EXPOSURE RATE.) Since gamma radiation travels some distance in air beyond the gamma-radiation source, the radiation field extends somewhat beyond the contaminated area.

RADIATION HAZARDS—Hazards to personnel caused by both (1) the initial nuclear radiations occurring in about the first minute following a nuclear-weapon burst and (2) the residual nuclear radiation from deposited fallout.

RADIATION MEASUREMENT—Measurement of radiation exposure rate at a point in air by a radiac instrument, or measurement of an exposure (the exposure rate accumulated over a given exposure time).

RADIATION SICKNESS—The physical condition resulting from a sufficiently large dose of gamma radiation. The first stage of illness can occur within a few minutes or a few hours after exposure. Symptoms are nausea, vomiting, diarrhea, etc. A latent period usually follows that may persist for a few days, a week, or more. The second stage of illness may last for several weeks, after which personnel will recover if the dose was not high enough to cause death.

RADIATION SOURCE—The radioactive elements emitting ionizing radiations. In this manual, fallout is the source considered.

RADIOACTIVE—Having the property of radioactivity. Emitting radiation.

RADIOACTIVE CONTAMINATION—See CONTAMINATION.

RADIOACTIVE DECAY—The decrease with the passage of time of the radioactivity of contamination. The decay rate of the fission products resulting from a nuclear explosion is very rapid immediately after burst, but very slow at later times.

RADIOACTIVE FALLOUT—See FALLOUT.

RADIOACTIVE WASTE—Contaminated waste and debris. For purposes of this manual it generally means the contaminated materials removed by reclamation methods.

RADIOACTIVE-WASTE DISPOSAL—Removal or isolation of the contaminated waste and debris, in such a way that the limited radiation is not a hazard to personnel.

RADIOLOGICAL—Pertaining to the effects of radioactive elements, particularly the biological effects of nuclear radiations on personnel.

RADIOLOGICAL COUNTERMEASURES—An action taken to reduce the exposure of personnel to nuclear radiation and thereby, in general, to permit the use of an area at an earlier time after contaminating attack than would otherwise be possible. The term includes all preattack, attack, and postattack measures whose effectiveness in reducing personnel exposure can be expressed in terms of RN's and PF's. They consist of three types: reclamation, shielding, and adjustment of operating procedures.

RADIOLOGICAL DEFENSE—A system of all measures taken to minimize the biological effects of nuclear radiations on personnel and their operations.

RADIOLOGICAL RECOVERY—The measures and effort required to reclaim an installation following contaminating attack so that the essential functions can be recovered and the installation's mission can be resumed. (See RECOVERY EFFORT.)

RADIOLOGICAL SAFETY—The personnel-protection measures taken against the radiation hazards resulting from nuclear attack.

RADIOLOGICAL SITUATION—The situation existing at any time during and after contaminating attack with respect to fallout-area exposure rates, radiation hazards, personnel exposures, and operations.

RECLAMATION—Consists of radiological countermeasures that reduce radiation-field exposure rates (and thereby radiation hazards) by removing the radioactive contaminants from the area or by covering the contaminants. For example, firehosing removes the contaminant; earth filling covers it. (See DECONTAMINATION.)

RECLAMATION EFFECTIVENESS—Degree to which the exposure rates of a contaminated surface have been reduced. (See RN, RESIDUAL NUMBER.)

RECOVERY EFFORT—The postattack effort directed toward recovery of the staging area and vital area so that mission operations can be resumed. The effort may include debris removal, damage repair, reclamation, application of shielding, etc. (See RADIOLOGICAL RECOVERY.)

RECOVERY OPERATIONS—See RECOVERY EFFORT.

RECOVERY PERSONNEL—Personnel assigned to do the recovery operations. These personnel may or may not be the same as those required for mission duties at the installation. However, they may be taken from among those installation personnel not required to perform the mission after recovery.

REFERENCE DOSE RATE—See STANDARD EXPOSURE RATE.

REM—Dose unit of biological effect, i.e., dose in rems = RBE × dose in rads.

RESIDUAL NUCLEAR RADIATION—Nuclear radiation, chiefly beta particles and gamma rays, which persists for some time after a nuclear (or atomic) explosion. The radiation is emitted mainly by the fission products and other bomb residues in the fallout, and to some extent by earth and water constituents, and other materials, in which radioactivity has been induced by the capture of neutrons.

RESIDUAL NUMBER (RN)—The measure of effectiveness of any countermeasure can be expressed in terms of a residual number (RN). The RN is defined as the ratio of the exposure rate after a countermeasure has been used to the exposure rate that would have existed if no countermeasures had been used.

RESIDUAL RADIATION—Nuclear radiations from fallout deposited on the installation. (See CONTAMINATION.)

RN—See RESIDUAL NUMBER.

ROENTGEN (r)—The unit of measurement used to express the radiation exposure as measured by a radiac instrument. An exposure of 1 roentgen, to a first order of approximation, produces a dose of 1 rad.

ROENTGENS PER HOUR (r/hr)—The unit of measurement used to express the rate of radiation exposure as measured by a radiac instrument.

SCRAPING—Reclamation method used on unpaved areas by which the top layer of contaminated soil is removed, usually by a motorized scraper, and transported away from the operating area.

SELF-READING DOSIMETER—A dosimeter that can be read directly by the person wearing it.

SHELFING—A radiological countermeasure that places or uses a barrier between the radiation source and personnel in shelter or in the work area. Natural shielding is the shielding resulting from already existing barriers (walls of a building, hills, etc.). Applied shielding (for example, sandbags) is a barrier constructed after contaminating nuclear attack to provide radiological shielding.

SHOCK DAMAGE—See BLAST DAMAGE.

STAGING AREA—An area which is reclaimed as the first act of the operational recovery phase, and where all personnel then live when they are aboard the installation and not in fallout shelters. It is selected so that it can be easily reclaimed to a low exposure level. It must be large enough to permit mission personnel to live there (when suitable shelter is not otherwise available) under reasonable conditions for the mission duration. It is the area from which recovery of the vital area is staged.

STANDARD EXPOSURE RATE—The exposure rate of a radiation field measured by a detector at an unprotected position at a height of three ft above a large open smooth land area at the standard reference time of one hr after burst. It is assumed that all the fallout has been deposited by one hr. The standard exposure rate is identical to the reference exposure rate.

STANDARD-EXPOSURE-RATE CONTOURS—The locus of all points on the ground at which the exposure rate in r/hr referred to 1 hr is the same, assuming all the fallout has arrived by 1 hr.

STAYTIME—The period during which personnel are exposed to a gamma-radiation hazard. It is the exit time minus the entry time.

SUBAREA—A part of the vital area whose exposure rate and contaminated surface are significantly different from other parts of the vital area.

SUBSURFACE BURST—A nuclear explosion that occurs underground or underwater. This type of burst will produce fallout.

SURFACE BURST—A nuclear explosion that takes place at or very near the surface of the ground or water. This type of burst produces fallout.

SURFACE ROUGHNESS—The roughness of an actual surface compared to a perfectly smooth plane surface. The exposure rate of the radiation field produced by a large, open, contaminated unpaved area is less for a given contamination level, since the contaminant particles are mixed, slightly buried, or shielded in the rough top layer of the surface and their radiations are therefore partially absorbed.

SURVEY—See MONITORING.

SURVEY METER—A rate meter. A radiac instrument used to determine radiation exposure rates in an area.

TRANSIT RADIATION—The radiation emitted from any airborne material. It is usually distinguished from deposit radiation, which is radiation emitted from material deposited on any surface.

VITAL AREA—The part of the installation that contains the essential functions and facilities and within which radiological-recovery measures may be necessary. The vital area of an installation is that area in which mission personnel perform the actual postattack mission of the installation.

WEAPON YIELD—The energy release of a nuclear explosion. It is expressed in terms of the estimated equivalent tonnage of TNT required to produce the same energy release. For example, a 20-KT weapon explosion would release energy equivalent to that of 20,000 tons of TNT; a 1-MT weapon, 1,000,000 tons of TNT.

WINDWARD—Toward the direction from which the wind is blowing.

APPENDIX III

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